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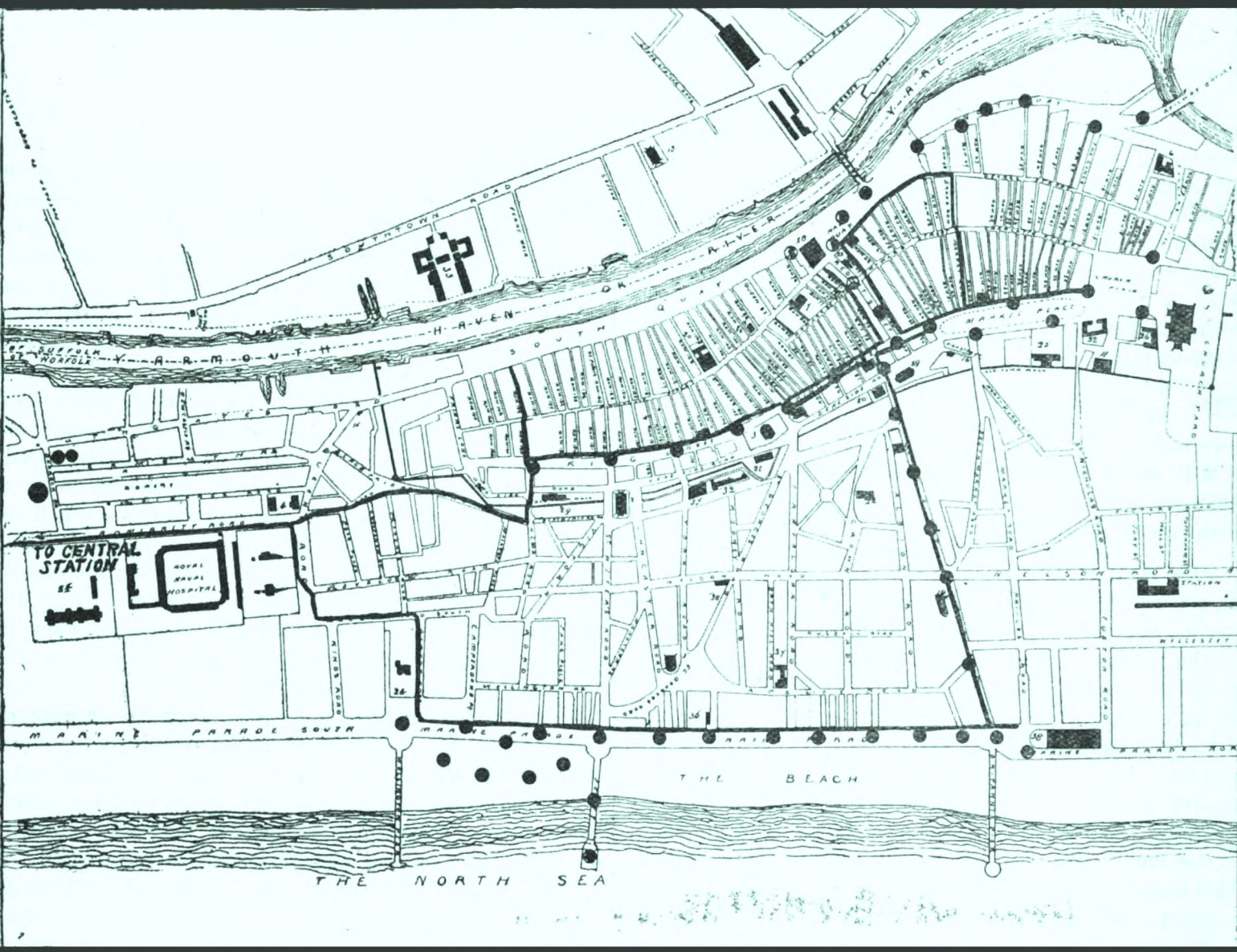

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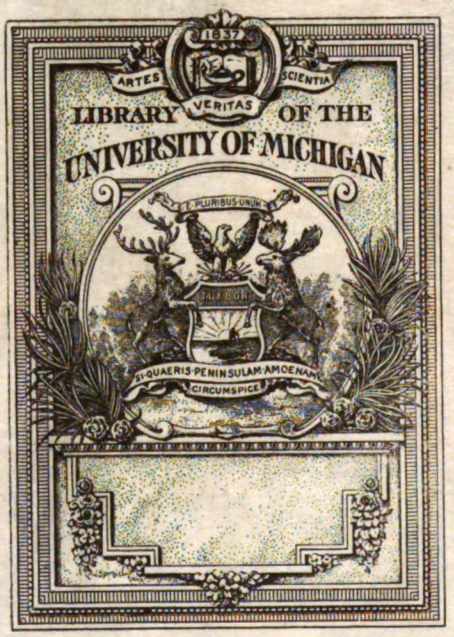

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THE

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NOTES.

Underground Electric Railways.—An interview with Mr. Greathead on this subject appeared in the *Daily Chronicle* of Friday last.

Telephony in Germany.—It is intended to establish in the spring telephonic communication between Karlsruhe, Offenburg, Konstanz, Freiburg, and Lörrack.

Institution of Electrical Engineers.—The inaugural address by the president, Mr. R. E. Crompton, M.I.C.E., will be delivered on Thursday next, the 10th inst.

Technical Education.—Lord Playfair contributes a survey of the advance of technical education during the past 50 years to the first number of the *Polytechnic Magazine.*

Calendars.—We are in receipt of calendars for the current year from Messrs. W. H. Willcox and Co., Southwark-street, S.E., and from Mr. S. Howes, 64, Mark-lane, E.C.

New Book.—We have received from Mr. John Heywood "Calvert's Mechanics' Almanack and Workshop Companion" for 1895, this being the twenty-second year of publication.

Cable Rates to South Africa.—It is stated that the conference of representatives of the South African Governments, has resulted in an agreement for the reduction of the cable rates being decided on.

Electric Lighting in the Canary Islands.—Oratavo, in the Canary Islands, is lighted electrically, water power being utilised for the purpose. The plant has been supplied by a Swiss firm.

Personal.—Mr. E. Garcke informs us that his future address will be 1 and 2, Great Winchester-street, E.C.—Mr. J. T. Gent, of Messrs. Gent and Co., Leicester, has been returned as a member for the new Board of Guardians for Leicester.

Institution of Civil Engineers.—This institution, which was established on January 2, 1818, and incorporated by Royal charter on June 3, 1878, for the general advancement of mechanical science, now consists of 6,660 members of all classes.

Electric Traction in Russia.—The local authorities at St. Petersburg have objected to the scheme of electric tramways brought forward by Messrs. Barons, Pauli, and Co. A local horse tramway company, will, however, apply for similar powers.

Blotting Pad.—We have received from the Electrical Power Storage Company, Limited, 4, Great Winchester-street, E.C., a combined blotting pad, calendar, and diary, which is very useful in itself, and is an improvement upon that of last year. Particulars are also given of the manufactures of the company.

Competition.—Dr. Oliver J. Lodge has taken up a new line of writing. We have received No. 3 of the Liverpool Fabian Tracts, which consists of a pamphlet by Dr. Lodge entitled "Competition *v.* Co-operation," in which he argues that the supposition that competition is a good thing is "a deadly fallacy."

Madras Tramways.—According to *Indian Engineering*, it is said that the Madras Tramways Company has filed a suit against the Electric Construction Company, Limited, in England, for heavy damages on account of delay in completing the contract with respect to the construction of the Madras tramways.

Students of the Institution.—A students' meeting of the Institution of Electrical Engineers will be held this (Friday) evening at 28, Victoria-street, S.W. The business before the assembly will be the election of a representative committee, and discussion on the papers read recently before the Institution dealing with electric traction.

Electric Traction in France.—It is proposed to establish a line of electric tramways between Montluçon and Néris.—An electric tramway is to be constructed between Montiers and Brides-les-Bains, Savoy, power being obtained from two neighbouring waterfalls. It will be operated only from April 15 to October 15 each year.

Catalogue of Electrical Publications.—The W. J. Johnston Company, Limited, of 253, Broadway, New York, have sent us a copy of their catalogue of electrical publications. At the same time they notify that the "Digest" published weekly in the *Electrical World* will be extended, so as to include American technical literature.

Electric Light in Indian Jute Mills.—The Seebpore and Howrah Mills, Calcutta, are to be electrically lighted, and the installation in each case will consist of 1,300 8-c.p. incandescent lamps, the current being generated by three E.C.C. dynamos, each coupled direct with a steam-engine. The contracts were placed direct with home firms.

Lahore Durbar.—The electric lighting of the Viceregal camp at Lahore, says the *Indian Engineer*, has been undertaken by Messrs. Kilburn and Co., and the temporary installation has been erected under the personal supervision of their electrical engineer, Mr. Scott Moncrieff. The dynamos are driven by engines lent by the North-Western Railway.

Trunk Telephone Lines.—A new trunk postal telephone line between Leeds and South Wales has been opened to the public. The charges for three minutes' conversation is as follows: between Leeds and Aberdare, Cardiff, Merthyr, or Swansea, 2s. 6d.; Ebbw Vale or Pontypool, 2s. A postal telephone line has also been opened between Merthyr Tydfil and Newcastle-on-Tyne.

Machinery Under the Indian Tariff Act.—The Government of India are about to lay down an explicit definition of the term "machinery" for the purposes of the

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levy of duty under the Indian Tariff Act of 1894. The question was raised in Bombay, and the Government of India have asked to be favoured with the opinion of the Government of Bombay and the Bombay Chamber of Commerce.

Telegraphy in India.—It is hoped to have another 120 telegraph offices opened during 1894-95. The Telegraph Department budget is now being prepared under the supervision of Mr. Brooke, director-general of telegraphs. It is impossible at present to say whether the budget will show a surplus, in face of the fact that the revenue from foreign telegraph despatches has decreased very considerably.

Electric Traction in Austria-Hungary.—Representatives of the towns of Crimmitschau, Meerane, and Glauchau have met and approved of a scheme for electric tramways proposed by Messrs. Siemens and Halske for connecting 19 neighbouring towns and villages.—Mr. Salesius Cathry has put before the local authorities of Budapest a project for an electric tramway between Ofner Brückenkopfe and Budakess.

Obituary in 1894.—In the course of a list of scientists who died in 1894 the *Times* includes the following: Prof. von Helmholtz, the great physicist; Prof. Heinrich Hertz, the eminent physicist of Bonn; Mr. Edwin Clark, the engineer and inventor of the block system of railway signalling; M. Paul Jablochkoff, the Russian electrician and inventor of the Jablochkoff candle; and Mr. Charles Arthur Redl, inventor of the dual system of signalling.

New Electrical Effect.—On New Year's Eve at the church of St. Mary-at-Hill, says the *City Press*, at five minutes to twelve "A Few More Years Shall Roll" was sung, during which the electric lights were gradually extinguished to represent the death of the old year. As the midnight chimes rang out a blaze of electric light in every part of the church announced the advent of 1895, "O God, our Help in Ages Past," being heartily sung by the large congregation, led by the rector's trombone, and assisted by a full orchestra.

Accumulator Traction in Vienna.—In a recent issue reference was made to a forthcoming trial of Waddell-Entz storage batteries for traction purposes in Vienna. It now appears that two accumulator cars on this system, similar to those operated recently on the Second-avenue surface road in New York, have been sent to Vienna, where they will be tested by a commission of representative electrical and civil engineers. The cars will be run on a line now worked by steam, and will thus be enabled to run at high speeds.

Electric Traction in Germany.—The tramway company of Strassburg, Alsace, intend to adopt electric traction on three of their lines. The work will be carried out by the Allgemeine Elektricitäts-Gesellschaft on the overhead trolley system, and it is expected that the lines will be in working order by May. A start will be made with 18 electric cars. Current will be obtained from the central electric light station.—The local authorities of Elberfeld have approved of a project by Mr. Langen for local electric lines.

Finsbury Park and City Electric Railway.—The Great Northern and City Railway Company, which was incorporated in 1892 for the purpose of constructing an electric railway from Finsbury Park to the City, have deposited a Bill for next session for the purpose of obtaining an extension of time from June, 1895, to June, 1897, within which to purchase the necessary land required for the railway. Consequent upon this extension, a further extension of time is sought until June, 1900, within which to open the railway for traffic.

A New Scare.—According to the Paris correspondent of the *Daily Chronicle*, the French Post Office authorities have received a communication from the Paris Faculty of Medicine setting forth the danger of spreading contagious diseases through the telephone. This, it is added, can be prevented by the use of a specially-prepared antiseptic paper. Diphtheria is said to be one of the complaints most easily propagated by telephone, and cases are said to have been traced to this cause amongst the women employed at the central and other bureaux.

Bordeaux Exhibition.—The Committee of Publicity formed by the London Chamber of Commerce in connection with this exhibition is informed that the South-Eastern and London and South-Western Railway Companies have agreed to the usual conditions for the carriage of exhibits—namely, full rates out and half rates home for exhibits returned unsold. The exhibition, which opens in May next and closes in the following November, is being organised and superintended by the Philomathic Society of Bordeaux. Intending British exhibitors desiring information should communicate with the secretary of the London Chamber of Commerce, Botolph House, Eastcheap, E.C.

New Publication.—Messrs. Whittaker and Co. inform us that they will issue to-morrow the *Technical World and Science and Art*, being the first number of a popular penny weekly. The new journal will embody the combined features of the *Technical World* and of *Science and Art*, two periodicals which have hitherto appeared as separate organs. It will appeal to all persons interested in the progress of art, science, and technology from an educational point of view, and its columns will be open to the discussion of all questions which may tend towards the improvement of methods of instruction. In addition to current news, the magazine will contain instructive articles by leading men in all the departments of pure and applied science and art.

City and South London Railway.—It will be remembered that the City and South London Railway Company have powers to extend their electric railway from Stockwell to Clapham, but this facility has not yet been taken advantage of. The Company have, however, now lodged a Bill for next session to obtain from Parliament an extension of time until July, 1901, for the purpose of completing this authorised extension. This extension, which is only 79 chains in length, was sanctioned in 1890, and an extension beyond the time originally granted was allowed by Parliament in 1893. The Company also seek power to raise £40,000 additional share and loan capital, of which £10,000 may be raised as debenture stock, and £30,000 as preference stock.

Borough Polytechnic Institute.—The Christmas conversazione in connection with the Borough Polytechnic Institute was held last week. The programme was extensive and varied, including concerts, limelight entertainments, photographic and art exhibitions, as well as electrical and telephonic exhibitions. A great source of attraction for visitors was the telephone department. Telephones were connected with half-a-dozen of the London theatres. Thirty pairs of receivers were at work, and in relays the visitors were afforded opportunities of listening to what was going on in these places of amusement. The institute has now about 2,300 members and over 100 educational classes, with numerous clubs and literary societies.

Electrical Communication with Lighthouses.—The Plymouth Chamber of Commerce last week had under consideration the subject of electrical communication with

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lighthouses. Mr. R. Bayly proposed that a memorial be forwarded to the Board of Trade with a request that, following the recent stranding of the "Dunottar Castle" on the Eddystone reef, steps may be taken immediately to establish electrical communication between lighthouses and the shore. It was true that the Trinity House authorities had given notice of their intention to establish electrical communication between certain lighthouses and the shore, but at the present rate of progress the work, which might be accomplished in two years, would not be done in 20. The resolution was adopted.

Wolverhampton Electrical Engineering Works. The inauguration of active operations by Thomas Parker, Limited, according to a correspondent of the *Engineer*, seems likely to be rendered memorable by the invention of a new dynamo, for which great things are promised. Only one of the machines has as yet been made by the firm, and it is believed that it possesses important electrical developments. It includes the Eickemeyer patents, the more recent patents in connection with armatures, and new inventions by Thomas Parker, Limited, which have just been patented. The dynamo so far built will be used to light the whole of the works, both inside and out, but the design of which it is the earliest outcome will be regularly employed in the execution of orders.

Electric Traction in Italy.—The Municipal Council of Milan have extended for six months the concession granted to the Edison Company for the operation of the electric tramway carried out a year ago on the Thomson-Houston system from the Piazza del Duomo to the Via Semprone. The omnibus company are laying down electrical plant for the working of two lines on the same system. In order to shorten the railway journey between Benevent and Naples, Messrs. Niseo, Civita, and Caneva propose to construct an electric railway of normal gauge between Benevent and Cancello, *viâ* the Candina Valley. The line will be over 20 miles in length, and will pass through San Felice, Ariezzo, Arpaia, Airala, Montesarchio, Arpaise, and Appollosa, at each of which places there will be a station. Various bridges will have to be built over rivers.

Post Office Telegraphists. — The Postmaster-General on Tuesday received two deputations of telegraphists, the first consisting of 12 men, representing all classes in provincial offices; and the second composed of six delegates, representing metropolitan districts. The chief subjects submitted were the unsatisfactory methods of promotion in the service, inadequate pay, superannuation, and the system by which many telegraphists are compelled "to take their so-called holiday in the winter months." Mr. Arnold Morley, in reply, said he sympathised with their holiday grievance, but he could not hold out much hope of meeting them on the other points raised. He certainly was not prepared to recommend the abolition of classification. He gladly recognised the ability and moderation with which the delegates had stated their case.

Transmission of Power in America.—Referring to the return of Prof. G. Forbes to England on the completion of the Niagara transmission enterprise, the New York *Electrical Engineer* says: "During this anxious and critical time, Prof. Forbes has, of course, been in most intimate relations with the managers of the great enterprise, and now closes his professional engagement under terms of entire friendliness and cordiality on both sides. The advice and opinion of Prof. Forbes have been eagerly sought in regard to other plans of electrical power transmission, and we are glad to know that the revival of trade and industry, long looked for and not now far distant, may necessitate his further and early visits to this country. We should not be surprised to learn that as the result of observation or experience here, Prof. Forbes may, *ad interim*, see his way to the encouragement of smaller power transmissions in England, where there are no Niagaras, but many available waterfalls, to say nothing of coal mines near large cities."

Taxation of Machinery.—A striking illustration of the effect of taxing manufacturers for their machinery is afforded by the recent action of the Newcastle Assessment Committee in connection with the revaluation of the works belonging to Messrs. Armstrong, Mitchell, and Co., at Newcastle-on-Tyne, the magnitude of which perhaps exceeds that of any works to be found elsewhere in the hands of private manufacturers. The result of the valuation was to increase the rating to nearly £37,500. This sum having been appealed against, prolonged negotiations ensued between the Machinery Users' Association, acting on behalf of Messrs. Armstrong, Mitchell, and Co., and the union valuer which resulted in a compromise by which the assessment was reduced by £12,000 in the ratable value. The whole of this amount appears to have represented the value of the machinery and tools, but as the settlement was a compromise, it is possible that even now the machinery remains rated to a considerable extent. The above reduction represents an annual sum of about £3,000 which the firm would have had to pay really as a tax upon their machinery had the association not been able to obtain that amount of relief for them.

What is It?—A correspondent writes to the *Times*: "Mr. John R. Wigham, president of the Dublin Chamber of Commerce, has invented a new lighthouse light, and has brought it experimentally before the science department of the Royal Dublin Society. It may be briefly described as a method of making the illumination of revolving lights continuous, instead of as at present recurrent after intervals of darkness. A boon to navigation which mariners have very earnestly desired is that they might have the benefit of the great power and characteristic appearance of revolving lights, and at the same time have them continually in their eye, as are the fixed lights round our coasts. Mr. Wigham has had long experience in lighthouse matters, and this invention of his is considered the greatest advance which has been made in the science of lighthouse illumination since the time of Fresnel. Mr. Wigham's previous inventions, which have been adopted to a considerable extent by lighthouse authorities, have been mostly in the direction of conferring increased power on lighthouse illuminants. This new invention supplements those which he has previously made, inasmuch as it is applicable to all lighthouse lights—gas, oil, and electricity."

The Word "Scientist."—In the December number of *Science Gossip* a protest was entered against the use of the word "scientist," and opinions on the point have now been received from some well-known men. The Duke of Argyll, Sir John Lubbock, Lord Rayleigh, Prof. Huxley, and Dr. Albert Günther unreservedly condemn the word. Sir John Lubbock suggests the word "philosopher," Lord Rayleigh approves Lord Kelvin's proposal to revert to the wider meaning of "naturalist," while Dr. Günther sarcastically suggests that "scientist" might advantageously be reserved to denote the modern dabblers in great scientific questions. Prof. Huxley thinks "scientist" must be "about as pleasing as 'electrocution'" to anyone who respects the English language. Prof. A. R. Wallace alone views the word with composure; he even describes it as "useful," and argues that since we have "biologist," "zoologist," "geologist," "botanist," "chemist," "physicist," "physiologist," and "specialist," we might as well use "scientist." He asks what there is to use instead, and

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expresses the opinion that it is too late to object to the word now. It is added by *Science Gossip* that the word was invented and explained by Whewell in his "Philosophy of the Inductive Sciences," 1840.

Electric Lighting in France.—The Municipal Council of Aix-les-Bains, Savoy, have decided to introduce the electric light.—The local authorities of Alais, Gard, have notified to the gas company their intention to introduce the electric light. The company have declined to exercise their right of priority, and, consequently, negotiations have been entered into by the municipality with Messrs. Louche, Bounefoi, and Froment.—The gas company of Angers, Maine-et-Loire, on the other hand, are asking for a concession for the electric lighting of the town. No decision has yet been come to, and in the meantime various private installations are being put up.—At Vire, Calvados, where the electric light was introduced two years ago, extensions of plant are to be made.—A concession has been granted by the municipality of Pornic, Loire-Inférieure, for the electric lighting of the town.—A central electric light station has been opened by the gas company at Saintes, Charente-Inférieure.—A new steam-engine of 100 h.p. will be added to the plant at the central station at Aubenas, Ardèche, by Messrs. Demange and Co., of Lyons.—The electric light is being introduced into Beaumont-de-Lomagne, Tarn-et-Garonne. The water power of the Gimone is utilised.—A limited company proposes to establish a central electric light station at Benzeville, Eure.

Current and Lines of Force.—The following rule, stated by Mr. B. S. Lampher in the New York *Electrical World*, gives the relation of the electric current to the lines of magnetic force produced by it: If you look at the positive (or north) end of an electromagnet, the direction of the current setting up the magnetism is that of positive rotation. Similarly, if you imagine a section made in a conductor carrying a current and look at the positive end of this conductor—*i.e.*, the end from which the current is flowing—the direction of lines of force set up about the conductor is the direction of positive rotation. Conversely, if you look at the negative (south) end of a solenoid, the direction of the current is that of negative rotation; and if you look at the negative end of a conductor—*i.e.*, imagine a section without really breaking the circuit—the direction of the lines of force about it will be that of negative rotation. Every student of electrical engineering knows that positive rotation, mathematically speaking, is opposite to the hands of a watch; and he also knows what is meant by the positive end of a magnet and the positive terminal of a conductor. Accordingly, if he remembers the rule at all, he cannot make a mistake like substituting "right hand" for "left hand," or "clockwise" for "anti-clockwise." It is a positive rule; positive end means positive rotation, and positive rotation gives a positive end.

Discussion of Papers.—Complaints have been heard here of the inadequate nature of the discussions on papers read on electrical matters, and in the current issue of the *Elektrotechnische Zeitschrift* an article appears in which attention is drawn to the same subject in connection with the German Elektrotechnischer Verein. It is pointed out that a thorough discussion upon a paper is the very thing which is required to make that paper of practical use for future work. Should a discussion fall entirely to pieces, there has been little use in the author reading the paper. He might as well present it to the members by simply printing it in the *Transactions* of the society. This course is, however, contrary to the *raison d'être* of a scientific society. The interest is not so much in the paper read, which is listened to usually in solemn silence, as in the personal exchange of opinions between the author and his hearers. The former should feel that the other members have given such consideration to his remarks that they are willing to contribute their experiences on the subject-matter, and even a sharp criticism, when confined to opinions and not personal, is preferable to an author than a silent reception of his paper. Two things are necessary for a good discussion: firstly, a proper grasp of the paper, which is obtainable by the circulation of advance proofs; and, secondly, the conquering of the timidity which, especially in the case of young members, makes them afraid to express their opinions before a large gathering.

A Large Alternator.—A large alternator, the great size of which has been rendered necessary by the conditions under which the machine is to be worked, and particularly the low speed, is now being constructed by the General Electric Company at Schenectady. This alternator, which is to be installed in the station of the Edison Electric Illuminating Company at St. Louis, Mo., will supply current for incandescent and arc lighting and for motive-power purposes. With a view to secure efficient results for these various uses, the generator is being constructed on the "monocyclic" system, which we recently described. This system employs a comparatively low frequency of alternations, and the armatures of the generators have special windings adapting them for use on circuits with self-starting current motors. The alternator in question is of 800 kilowatts capacity, has 80 poles, and is to be driven at 90 revolutions per minute. On account of the great size of the frame difficulties were expected in producing the castings, but owing to the facilities of the Schenectady works, no trouble was experienced in pouring even the large frame casting. This single piece, made up in part of wrought iron embedded in the castings, weighs 35 tons, and measures 24ft. over all. The armature is iron-clad and is 16ft. in diameter, weighing nearly 45 tons. The armature will be supported on a 22in. shaft. The generator will be able to supply, at full load, 667 amperes at 1,200 volts, or the equivalent of 16,000 16-c.p. lamps.

Electrical Work in the Baltimore Tunnel.—The Maryland Steel Company has secured the contract for making and erecting the overhead electrical equipment for use in the Baltimore (U.S.A.) Belt tunnel. Instead of using an overhead wire for the circuit, the General Electric Company, which is building the motors to haul Baltimore and Ohio trains through the tunnel, has decided to build an iron trough 1½ft. in circumference. A flexible wire will be attached to a shoe fitted into this ironwork, and will by this means carry the current to the motors of the engine. The purpose in using the hollow trough and the shoe is to avoid delays which may occur in the slipping off of the trolley wheel. Another advantage is secured in having a flexible wire for the electric connection instead of an upright iron pole, which does away with the necessity of shifting the pole every time it is desired to reverse the engine. The iron trough will be of heavy workmanship, and the work built to support it will be of light iron bridge construction. Iron poles will be placed 30 yards apart for that portion of the track inside the tunnel. On these poles will rest a framework of light iron, which in turn will support the trough. In the tunnel the trough will be near the centre of the tunnel roof. There it will be held in place by iron braces, also placed 30 yards apart, and fastened by bolts to the side of the tunnel arch. The overhead work will extend from Henrietta and Howard streets on the south to a point north of Huntingdon avenue, where the tunnel work of the Belt line ceases.

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The Government and the Telephone.—A Newcastle paper says: "As is well known, the Government are now engaged in establishing telephonic communication throughout the country. According to the draft agreement laid on the table of the House of Commons, and to be submitted for approval in the coming session of Parliament, it is proposed to take over the trunk lines of the existing companies, but not to interfere with local services; and meanwhile other trunk lines are being provided. Some time ago the line between Leeds and Hull was opened, and similar means of communication between Leeds and South Wales are now available. The wire by which the latter is obtained, however, extends from the North-East of England to South Wales. Blaydon, Blyth, Durham, Hexham, Jarrow, Middlesbrough, Morpeth, Newcastle, North Shields, Ryton, South Shields, Stockton, Sunderland, and West Hartlepool, with Hull and Leeds, are now in direct communication with Aberdare, Barry Dock, Briton Ferry, Cardiff, Ebbw Vale, Merthyr, Newport, Pontypool, Swansea, Talywain, and Tonypandy. The wires laid down are of a specially large gauge, a thick wire being necessary for long-distance communication. The wires are of copper, and for the longest distances that used is nearly as thick as an ordinary lead pencil, weighing about 800lb. per mile. The cost will, therefore, not be of trifling amount. The Government are wisely determined, however, that the country's telephones shall be thoroughly efficient. So far the results are highly satisfactory. Trunk lines are now in course of construction from Leeds to London, Glasgow, Edinburgh, Belfast, Dublin, Manchester, and Liverpool, and these, along with those already in existence, will, so to speak, form the backbone of the Government system. The charges for conversations may at present be considered high—a three-minutes' talk between Blaydon and Cardiff, for example, costs 3s. 6d.—but the value of such a convenient, quick, and reliable means of communication, more especially to those engaged in commercial transactions, and where time is of importance, is not to be questioned."

Muzzle Velocity of Shot.—In the course of his first Cantor lecture delivered before the Society of Arts on "Explosives and their Modern Development," Prof. Vivian B. Lewes referred to the method of determining the muzzle velocity of shot which is effected by means of the chronograph. He said: "Two screens are arranged, one about 120ft. from the muzzle of the gun, and the second 120ft. beyond the first. These screens consist of wooden frames strung with fine copper wire, the disruption of a single strand of which is sufficient to break the flow of the galvanic current. In the Boulenge chronograph, a current from a battery of eight Bunsen cells flows through these wires and back to the instrument-house, where the wire from each frame is coiled round a separate soft iron core, and converts it into an electromagnet, each of which attracts and holds a rod of steel. The electromagnet in connection with the second frame is fixed at a lower level than the electromagnet connected with the first, and carries a short rod with a weight at the bottom, whilst the first magnet is at a much higher level, and carries a longer rod. The current being allowed to pass through both electromagnets, the rods are suspended in position. By pressing a key both circuits can be simultaneously broken, with the result that both the rods are liberated, and drop down guide tubes; the short rod strikes a catch, and causes a knife-edge to be brought against the longer falling iron, and to make a nick in it. When both rods are liberated simultaneously, this nick occurs at a definite place. The current is then allowed to pass, the rods hung on the electromagnets, and the gun containing the charge, the power of which is to be tested, is fired, the projectile passing through the screens and breaking the current by cutting the wires. Under these conditions the long rod is liberated a fraction of a second sooner than the shorter rod, the result being that the nick of the knife blade is no longer in the original place. By measuring the distance between the two nicks, and knowing the length of time to which this is equivalent, allowance being made for the time taken in liberating the knife blade, etc., the interval of time which elapses whilst the projectile is passing between the screens can be calculated, and, being corrected for the distance of the first screen from the muzzle, gives the muzzle velocity of the projectile."

Quantitative Analysis by Electrolysis.—In the *Berichte*, Mr. A. Classen gives a description, accompanied by plans and a sketch, of the manner in which the private laboratory and a bench in the inorganic laboratory are fitted up for electrolysis at Aix-la-Chapelle. At the bench 24 electrolyses can be simultaneously carried out, and the current in each electrolytic cell can be measured by means of an ampere-meter common to the set. The usual method of measuring the current with a gas voltameter before the electrolysis is commenced is very faulty. The author uses an ampere-meter, which can be thrown into circuit during electrolysis by adjusting a copper bridging wire between two mercury-cups. When the measurement is made, the bridge is removed and connection made so as to cut off the ampere-meter, but this time by means of a bridge having a resistance just equal to that of the meter; the current in the circuit thus remains equal to that at the time of measurement. The current is not quoted, but the current density, or the number of amperes per 100 square centimetres of surface of the electrode. The solutions used were commonly made by adding ammonium, or occasionally potassium oxalate, to a solution of the salt of the metal, some free oxalic acid being also usually added. In the case of antimony, however, sodium sulphide was added, and, in the case of silver, potassium cyanide. The deposits were dense and metallic. With lead, the electrolysis was carried out in the presence of nitric acid only, and the deposit of peroxide weighed as such. With manganese, it was done in the presence of acetic acid only, and the precipitate of peroxide was ignited and weighed as Mn_3O_4. In the case of mercury, tin, antimony, lead, and manganese, it was found expedient to use, not a polished platinum dish, but one the surface of which had been made matt by means of a sand blast; the deposit often adhered to this when it would not adhere to a smooth surface. Below are given details of current density in amperes, difference of potential of the electrodes in volts, temperature, and duration of the electrolysis as employed in depositing various metals.

	Current density, amperes.	Diff. of potential, volts.	Temp., deg.	Time, hours.
Copper	1·0-0·35	3·2-2·5	58-60	2-2½
Cadmium	1·0 0·5	3·4-2·75	68-76	3-3½
Zinc	1·0-0·5	4 8 3·5	55-60	2
Iron	1·5	3 4	20-15	½-¾
Nickel, Cobalt	1·0	3 0-3·5	60-70	2¼-2¾
Mercury	1·0 0·2	4·7 2 6	23·37	1½-5¼
Silver	0·5-0·2	4·8-3·3	20-30	1¾ 5
Tin	0·3-1·0	3·2 4·2	25-30	5¾-6½
Antimony	1·5-0·3	1·85-0·85	25 60	2-17½
Lead	1·65-1 45	2·5-2·4	60-65	1-1¼
Manganese	0 3	4·9-4·3	50-68	3

Similar details are also given for the separation of lead and copper, copper and iron, antimony from arsenic and from tin, copper from nickel and from cobalt, iron from aluminium and from chromium, and for the simultaneous deposition of iron and cobalt and of iron and nickel. The methods used are already well known.

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IT WAS A DREAM.

It is often said that a man's dreams are as a rule connected with his waking thoughts, though the connection may in many cases be extremely indirect, if not absolutely topsy-turvy. I am afraid the latter condition must have held good in a dream that came upon me lately, after a long tussle with the things of to-day, but I would that it were otherwise.

On the occasion named, "me befel a ferly," as the old poet says: I dreamt that among the morning letters one day there was a polite note from the secretary of the well-known multi-millionaire, Mr. Roth Vander Astorschild, asking me to favour that already much-favoured gentleman with a call on the following afternoon at such and such an hour, with apologies for the short notice, etc., from "yours very faithfully." In the terms of the *Court Circular*, I was commanded to appear before the great commercial presence: and this I was in nowise loth to do, though the nature of the business at issue was beyond my imagination for the moment. When the appointed time came next day, however, and found me—after putting all else aside—in the magnate's waiting-room, I was soon enlightened, for the inner door had barely opened for me to pass through, when Mr. Astorschild gave a courteous salutation and plunged at once into business.

"You have," he said, "some knowledge of electric traction, have you not?" I modestly replied that it was and had been for long a matter of special study, but that the amount of my knowledge depended largely upon what was required therefrom. "What do you consider will be the course of developments in this branch during the early future?" he then asked. To this I replied that electrical engineers in general were hoping to see great progress made in the direction, not only of suitably converting lines (now worked by horses) for mechanical traction methods, but also of erecting and equipping a number of extensions to these, as well as many light railways all over the country; and for all such lines the use of electric energy as the motive power should have an excellent chance of adoption. "Why?" Because of its greater economy in point of first cost and working expenses, more particularly when the overhead wire or trolley system is employed. This method is under average conditions proved to be decidedly the cheapest, and, therefore, should be made standard. "Yes, I agree with you; this is just what I understand from the reports already made to me. Now, what is really being done to introduce and further the development of such a system on the English tramways?"

In reply, it was only possible to say that a few localities in the country were enterprising enough to take active steps in the matter; there were, for instance, Leeds, Walsall, Dublin, and Bristol, in all of which electric trolley lines were being worked or projected. "But what of London, the Metropolis itself? What is the use of beginning in the provinces: why not start at once in the headquarters of all the business and commercial life of the country?" I felt rather small on being forced to reply that London, of all places, was the very last where any efforts in this direction seemed likely to attain the least success. Not only had the County Council made up its mind (in absolute ignorance, it must be feared, of the true conditions or arguments on either hand) that overhead wires for such a purpose were equally iniquitous with sky-signs and telephone-wire networks, but the state of affairs in London at the present time in regard to tramway matters was an absolute deadlock that promised to endure for a generation at least.

"How many omnibuses are there now running upon the London streets?" I couldn't give exact figures, and merely voiced, in reply, the unanimous feeling of all who have ever thought of the matter, saying that there are just ten times as many as the streets will accommodate, but not one-tenth the number required to do justice to the traffic, simply because they can only travel at a snail's pace. "Does an electric tramcar, even when operated from an overhead conductor, take up any more room than an omnibus?" "Much less," I replied; "but the fact that they can maintain with perfect safety a much higher average speed would justify their existence on London streets, because so much fewer would be required for carrying on the traffic, even if individually they took up more room than omnibuses."

"Then we must get to work at once to build lines into the city from the principal suburbs. My brougham is continually being hindered by these crawling omnibuses when driving into the city, and I shall be glad if you will, on my behalf, take immediate steps to arrange the whole business ——" Here his voice became suddenly low and distant, whilst his figure grew very misty, and the whole room more like my own fireside, where I presently found myself a living dreamer with thoughts strongly proving the theory of association in ideas by comparison, for instinctively my mind had jumped to the happiest lot in life that it could imagine compared with the princely opening thus made with its attendant tasks and burdens. I woke up wondering how much Hodge was paid for breaking stones by the wayside.

K. N. A.

CONTROLLERS.

BY FRANK B. LEA.

Nothing could show more clearly the great difference between the condition of electric traction work in this country and the United States respectively than the fact that the word "controller" is at present a household term in the latter, whilst we only know it here in a restricted and narrow sense. There is probably not a street-railway manager or other official across the Atlantic who could not dilate upon the theory and characteristics of the controller as applied to the working of electric tramcars, whilst on this side, if the average tramway-man were asked what his opinions might be as to the best controller, his mind would doubtless revert at once to the dignified personages who preside over her Majesty's Patent Office and Board of Inland Revenue. Of course no injustice is intended, or is even possible to be done, in this connection to an excellent body of men; the fault lies in circumstances not having allowed any progress to be made in improved methods whereby new systems—and a new language—tend to arise.

Eight or ten years ago the pioneers in electric traction work were contented with a simple switch for cutting in or out the motor employed to drive a tramcar, and the idea of regulating the speed or the current passing through the motor was an elaboration of detail not yet thought of. Then the excessive starting currents and frequent burn-outs suggested the use of resistances, and these led to the employment of compound or multi-point switches for varying the resistances in circuit.

Finally, the late Anthony Reckenzaun conceived the idea of regulating the current by variations of the resistance of field-magnet coils, instead of or in addition to the use of artificial and extra resistances: and this plan, elaborated by Sprague and others, has proved the basis of a regulating appliance which combines all these advantages in a single and compact piece of apparatus, with the result that very great economies are effected in the capital outlay, in the amount of energy used for stated work done, and in the cost of repairs, labour, and renewals throughout the fixed and movable plant of an electric tramway. The controller is to-day something more than a regulator of current: its employment has literally controlled—in the sense of fostering—the development of electric traction, and the man who "twists the handle" has a piece of mechanism under his charge that is most essential to the well-being of the entire system.

The controller in its present form is, however, perhaps not altogether perfect, though to examine one is sufficient to show the enormous progress that has been made upon early devices. In essence it consists of a series of contacts arranged cylindrically or in barrel shape upon a vertical axis, which is rotated by means of a handle. Its angular movement effects changes in the contacts, so that, beginning from the cut-off position, the motors are switched in in series one with the other, and with a resistance; then, the latter is cut out and again cut in in series with the motors that are now in parallel, the action tending to regulate the current in

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accordance with the car speed. Of course, the total movement is much less than the complete circle, a reverse motion of the handle being used in stopping the car. To reverse the *direction* of the latter, a separate reversing handle at the side of the controller stand is usually employed. A motor switch overhead and the ordinary brake handle complete the regular equipment of an electric tramcar, and it may be thought that the motorman will find plenty to do in properly looking after his operating gear. This leads to the consideration of other possible forms of controller gear.

For ordinary or service stops, there is not in any way too much for an intelligent motorman to do. He simply runs the controller handle back, cuts off the current, and twists the brake handle. Emergency stops, however—which are just the occasions when men get rattled, although usually of iron nerve—require, it may be, the reversing lever to be thrown over, and in the hurry to do three things at once the chances may be that none are carried out properly. The possibility of the controller handle being turned or kept in the wrong direction has led some to advocate a form of switch gear with a fore and aft straight line motion, just as in steam-locomotive work the lever reverse gear is much preferred in certain cases to the use of a screw, if only to prevent mistakes. Trouble may be partly avoided by so interlocking—as is now usually done—the reverse lever and controller spindle that the current through the motors can only be reversed under suitable conditions, but there is much to be said for an action of the controller gear which shows in itself what the attendant result will be. This course is usually followed with cable cars, and might be considered yet again for electrical working, though the valuable compactness of a cylindrical controller would be almost entirely lost.

PROGRESS OF THE ELECTRIC TELEGRAPH.

Although little more than half a century has elapsed since the first telegraph line was opened in Europe, recent statistics, says the *Times*, show that telegraphy has made astounding progress. Germany can claim the honour of being the first country in which a telegraph line was opened. This was in 1833, and four years later Cooke and Wheatstone made their first successful effort in England with the telegraphic communication between Euston and Camden Town, on the London and North-Western line. The first telegraph line really set up in England, however, was that between Paddington and West Drayton, on the Great Western line, which was established in 1838. The United States succeeded in 1844, and then came in the following order Belgium, Austria, Italy, France, Holland, Switzerland, Sweden, Russia, Denmark, Norway, and Spain. Selecting the year 1870 as an example for the despatch of messages, we find that the smallest number despatched was 466,700 by Norway, and the largest, 9,350,000, by Great Britain. Germany had already fallen to the third place in the list with 8,207,800 messages, the United States being second in the list with 9,157,646. Twenty-two years later (1892) Norway had still the smallest number of messages carried—namely, 1,649,544. Germany was now fourth in the list with 31,175,100. No figures were forthcoming for France in 1892, but in 1891 the number of messages carried in that country was 32,397,000. The United Kingdom still retained the first place, its total in 1892 being 69,908,600, compared with 62,387,298 in the United States. Austria held fifth place in 1892 with 10,835,302, and Italy seventh with 8,322,925. With regard to the proportion between the number of messages carried and the population, in 1870 Russia was lowest on the list, the messages being only 0·04 per head of the population. Next in rank to Russia, as being the lowest on the list with regard to the proportion of telegrams to population, in 1870, were France, Italy, Sweden, Spain, and Hungary; but since then France has made great strides, and is now among the first five countries, having increased from 0·1 to 0·9. Switzerland was first in 1870 with 0·6 message per head, but the United Kingdom took first place in 1892 with 1·8 per head.

THE FUTURE OF ELECTRICITY.

BY SYDNEY F. WALKER.

Whenever one engages in conversation with anyone not in the ranks of electrical engineering, it rarely happens that one's friend does not remark very early in the conversation that "electricity is still in its infancy," usually prefacing the observation by the statement that he personally knows nothing of the subject. The observation has been made so often that one really becomes very tired of its incessant repetition, and we feel strongly inclined to beg our friends not to repeat the old saying too often. Yet after all, when we consider the question, is it not true in spite of what has been done during the last 60 years, and particularly during the last 20?

Judged by the age of other branches of science electricity is still an infant, with all its manhood's work yet to accomplish—work that none who are now its servants can hope to take part in; work that few of us can even venture to foretell. It is by the use of steam and of electricity that the modern world of the nineteenth century is distinguished from the older worlds that have gone before. What might not those mighty races of bygone ages have accomplished had they been blessed with such servants as these? And even now, while steam is young, as the universe judges time, the handwriting is on the wall, not, as at the Eastern monarch's feast, in strong condemnation of the empire that is passing away—for steam has been a faithful servant, and will be for many years to come—but as a warning that its days are numbered, nevertheless. And may it not be also in the future that even the young giant we serve, whose infantile deeds are so prodigious, will have to give place to another agent as yet unknown? If it be that electricity and electromagnetism, with sound, light, and heat, are merely varying forms of the same thing, varying rates of molecular motion, can we suppose that there are not other rates of motion possessed of other properties possibly still more wonderful than those that have surprised the present generation? Between the molecular motion we know as sound and the slowest of the motions we know as invisible heat, there is room for many other rates.

But what may we hope for in the future from electricity itself? First, then, the gradual utilisation of the forces of Nature known as wind and water power, to the gradual displacement of power from the combustion of coal. At irregular periods the world is startled by the cry, What will become of us when our coal fails? We are turning out an increasing number of millions of tons yearly, and the supply is limited. We are squandering our national wealth. What is to become of us as a manufacturing nation? Long before the supply of coal approaches exhaustion its price will increase and our other industries will be crippled. What are we to do? The reply is, in my opinion, that long before the price of coal rises from this cause coal itself will have to fight for its life as an industrial product, just as gas is now doing, the antagonists being wind and water power, delivered where required by the aid of electricity.

And what about gas? Only twelve months since it was safe to prophesy, as far as could be seen then, that gas was doomed to extinction at no distant period. The perfection and adoption of the Welsbach incandescent gas-burner will probably give it a new lease. If the Welsbach apparatus becomes universally adopted, and the gas companies are able to carry out their threatened revolution, the supply of a heating gas only—necessarily a much cheaper gas—electricity will have received a very serious set-back, the most serious it has received during the last 20 years. Once the price is reduced, gas will be used much more for heating and for power than it is now, and while at present the running cost of an incandescent lamp is twice that of an ordinary gas-burner in any district, and power costs four times as much when taken from any town's electric supply mains as it costs when taken from the gas service, the proportion when cheaper gas is supplied will be very much greater. But a little consideration will show that the set-back will be only temporary, can be only temporary, unless electrical engineers alter very considerably during the next few years. The principle of the Welsbach burner,

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or its equivalent, must be adopted in the electric incandescent lamp of the future. In the Welsbach burner we have a substance capable of withstanding a high temperature with the necessary heat applied to the substance from outside by means of the combustion of gas. When electric lamp-makers find a substance that will stand very much higher temperatures than the present incandescent lamp filaments do, the Welsbach burner will again have to take a back seat, and electricity will have made another stride, and a very long one, in its progressive fight with its rivals, since in addition to reducing the running cost of the lamp itself, its greater efficiency will enormously increase the earning power of the plant and cables.

In the matter of power, too, the gradual education of consumers in the use of higher voltages will gradually decrease the running cost. There is one use of electric power, however, for which the present outlook does not seem very hopeful—viz., for tramcar driving.

Notwithstanding all that has been done in America, and the special cases in this country where electricity has been successfully employed, apparently it must be some years, many years, before it can be generally applied to the ordinary street service, unless some unforeseen discovery should be made very shortly. America is not England, and the Black Country is not England; and no matter what may be tolerated there, no English town of importance would be likely to allow the hideous arrangements necessary for the overhead system in any of its principal thoroughfares. The conduit system and the accumulator system await the march of invention. Both are barred by the excessive cost of running.

Heating by electricity, though only recently introduced, has already made rapid strides; and although where the current to be used for heating is taken from the town supply the cost is still so excessive that it can only be regarded as a luxury, yet there are now many cases where the extra convenience is well worth the extra cost, and there will be many more as time goes on, and as the natural development of the lighting industry produces the usual effect—viz., gradual reduction of cost.

Telephones are daily becoming more and more used, and hence more and more useful. The future for them should mean still further usefulness by reason of more perfect service. In the future, too, we may hope to have communications by telephone without wires. Shall we also see by electricity without wires? In mining and general industrial work, the progress of electricity in the past and the hopes for its future leave nothing to be desired.

Whether Messrs. Thwaites and Swinburne's idea of burning the coal and the gas generated in coal mines at the pit's mouth, and distributing to centres of industry, is ever realised will depend on how soon the developments of wind and water power are made. Possibly some such scheme may come in to assist coal in its battle, in the same way that the Welsbach burner has come in to assist gas now.

Local conditions, too, will largely rule whether coal, wind, or water shall be used, since the initial outlay will be approximately the same, and the voltages used may be the same. But, since for both the economical consumption of coal at large centres and the utilisation of wind and water power, high voltages will be necessary, and the higher the voltage that can be employed the more economical will be the working of the system, may not engineers indulge in a yet bolder dream?

The dream of ages, the utilisation of the gigantic energy of Niagara, is now, in part at least, an accomplished fact; is it too bold to dream of using the energy of the agent that creates Niagara, the sun itself, by the aid of electricity, to neutralise some of the effects created by the absence of the sun's rays? Daily, hourly, the whole year round, enormous quantities of energy are delivered directly to the earth, within the tropical zone, yet during the whole year large tracts of land are rendered absolutely valueless to man owing to the want of the heat so abundant in the tropics, while even yet larger tracts are deprived of a considerable part of their fertility from the same cause. Is it too bold a dream to imagine a portion of the superfluous heat of the tropics delivered within the icebound regions by the aid of electricity? What would our ancestors have thought if anyone had foretold in their days the present use of Niagara?

Once more, too, if what we know as electricity be a form of molecular motion at a lower rate than the slowest of the invisible heat waves, the day on which it becomes possible to reduce the rate of the molecules, when vibrating under the influence of heat, directly until their motion corresponds with the rate we know as electricity without the at present necessary repeated transformations, an enormous stride will have been made towards neutralising the inequalities of climates on our globe. And there is even yet another manner in which we may hope that electricity may help us in our battle with the inequalities of Nature.

It is now some years since Lord Rayleigh discovered that the large raindrops we are so familiar with in thunder showers are due to the electrification, and consequent aggregation, of the fine particles of moisture present in the atmosphere. It is also some years since Prof. Oliver Lodge added to Lord Rayleigh's work the discovery that floating dust particles might be aggregated in the same manner as the raindrops are by discharges of static electricity. Yet beyond an apparently crude experiment on lead dust, no use has been made of either of these brilliant discoveries.

Is it too bold, wickedly bold, to hope that in the future by means of electricity we may be able, at least in part, to control our seasons? Why need we have a dry summer, as in 1893, when the moisture is present in the atmosphere, and can be made to descend? Why need we have superlatively wet seasons if the atmosphere is not allowed to retain a superabundance of moisture, when it may be caused to discharge its cargo when desired? Why should not our Government vote a large sum to working out these problems? Can we doubt that if the discoveries had been made by French physicists the French Government would not have given every assistance, instead of standing coldly by, supremely indifferent until the time arrived when the discovery may bear taking? Is it too much to hope that the coming year may see some little thing done in this direction?

THE MANUFACTURE OF CHLORIDE ACCUMULATORS.

In our last issue we referred to the acquisition by the Electric Storage Battery Company, of Philadelphia, the owners of the chloride accumulator patents, of all the fundamental storage battery patents in the United States. In this connection it is interesting to note that the chloride battery which has been introduced in England by the Electrical Storage Syndicate, Limited, of 16, Victoria-street, S.W., forms the subject of an illustrated description in the New York *Electrical Engineer* of December 19, from which the following is abstracted.

Homogeneity in the active material is a *sine quâ non* of a successful storage battery plate, and while spongy lead may be reduced from a number of different lead salts, there are but comparatively few that are at all suitable for storage battery purposes, and among these the chloride of lead has been found by the company after a long series of experiments to be the best adapted. In order to be certain of the purity of its working materials, the company itself from the very start undertook the manufacture of the chloride of lead, and developed special processes to that end. The first step in the production of the chloride consists in reducing commercial lead to a fine powder, which is accomplished by directing a blast of compressed air against an orifice from which issues a fine stream of molten lead. The result is a spray of lead which cools and falls as a powder. The lead finely divided in this ingenious way is next dissolved in nitric acid and then precipitated as chloride of lead by the addition of hydrochloric acid. The white chloride of lead, after being thoroughly washed and dried, forms the basis of the material which subsequently becomes active in the battery plate, and as such its production is carried on with the greatest care and supervision to prevent the introduction of impurities.

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The casting-room contains two large furnaces, in which the chloride of lead, mixed with a certain proportion of chloride of zinc, is brought to a molten state. These crucibles are heated by a furnace in which crude petroleum is burnt by means of a steam spray blast. The pastilles which subsequently form the active material of the battery are cast in a mould, the metal being ladled out by the workman. These pastilles are not poured solid, but the mould is so arranged as to leave them with a hole in the centre, by which they are subsequently located and held in position in the casting frame of the lead mould.

To those who have witnessed the old method of pouring lead storage battery grids by hand, the method here adopted will prove a source of much interest. Instead of the old slow and somewhat uncertain method the arrangement adopted is the forcing of the lead into the grid under pressure of 75lb. to 180lb. per square inch, depending upon the size of the plate, filling the mould completely, and leaving no chance for blow-holes. The chloride pastilles are placed in the mould, being held in position by pins projecting through the holes provided at their centres. The mould is then introduced into the lead-casting press, a turn of the handle opens the valve leading to the lead furnace, and a turn of a second valve admits the air pressure, which forces the lead into the mould. The entire operation requires less time in its performance than that occupied in describing it here, and the result is a grid firmly grasping the pastilles. The lead employed has a slight addition of antimony to aid in giving it stiffness and non-corroding properties. The two furnaces have a capacity for casting 10 tons of battery plates per day. After they leave the press, the plates are finished and scraped smooth, and are now ready for the next process—that is, the reduction of the chloride.

The plates are stacked by alternating each lead plate with a slab of zinc, all immersed in tanks filled with dilute chloride of zinc. The plates so assembled constitute, in fact, a primary battery, and by short-circuiting them the chloride of lead is reduced. The chlorine leaving the pastilles forms chloride of zinc, and the pastille is finally reduced to crystalline lead. After the reduction is complete it only remains to wash the plates thoroughly in running water in order to remove the last traces of zinc chloride. The reducing process occupies about 48 hours. The reduced plates are now assembled and have the lead connecting lug burnt on them by means of the hydrogen flame. The plates that are intended for the negatives of the cell require no further treatment, as they contain the pure spongy lead, but those designed to act as anodes or positives must, of course, undergo treatment to convert the spongy lead into the peroxide. The plates, immersed in tanks filled with dilute sulphuric acid of the proper strength, receive a continuous charge of two weeks' duration in one direction, which thoroughly converts the spongy lead into peroxide. The current for forming the plates is furnished by one 500-ampere and two 200-ampere machines of 125 volts each.

With the peroxide completely formed the positives and negatives are now ready to be assembled. In order to ensure the integrity of each individual plate, special means are provided in the chloride cell for maintaining the plates of opposite polarity separate from one another, and for this purpose each positive plate is first covered on both sides by a sheet of asbestos cloth. In addition to this, however, a further stiffening is obtained by the introduction of a partition of cherry wood, which is perforated by numerous holes, the perforations being connected by grooves so as to admit of the free circulation of the electrolyte. The output of the company's factory embraces a wide range of sizes, and the purposes for which the cells are used are equally numerous. Thus, in one of the rooms we note the 1,000-ampere-hour cells, which will be shortly installed in the Edison Illuminating Company's station in New York. At another point we see cells made up into portable groups of two, three, and more for electro-medical purposes, and at another we find a case designed as a portable outfit for a theatrical company, and again sets of small cells 2in. by 4in., containing three plates, intended to be used in connection with long-distance telephone sets.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 745, Vol. XIV.)

39. *Relative Permeances in Dynamo-Electric Machines.*—(*a*) *Principle of Magnetic Potential.*—In taking the magnetic potential between two pole-pieces of opposite polarity as unity for calculating the relative permeances in dynamo-electric machines, the potentials between various points of the magnetic circuit depend upon the number of electromagnets magnetically in series between two consecutive poles of opposite polarity.

If, as is the case in the majority of types, there are two magnets between any north pole and the next south pole of the machine, then the magnetic potential between two points, x and y (Fig. 57), of the magnetic circuit separated by but one electromagnet is $=\frac{1}{2}$; and two points, y and z, of the magnet frame not separated by any exciting coil, have no difference of magnetic potential, their potential $=0$. If the circuit consists of but one electromagnet, or of several magnets magnetically in parallel, then the magnetic potential between any two leakage surfaces of opposite polarity is $=1$—*i.e.*, equal to the difference of magnetic potential between the pole-pieces.

The observance of this general principle enables us to bring all the relative permeances into proper relation to each other, and we can now apply formulæ (112) to (118) to the cases of a dynamo.

(*b*) *Relative Permeance of the Air-Gaps* (P_1).—According to (112) the relative permeance of the air-gaps can be expressed by

$$P_1 = \frac{A_g}{l_g} \quad . \quad . \quad . \quad . \quad . \quad . \quad (119)$$

if A_g = area of gap spaces—*i.e.*, the mean of pole area and surface of armature core in square inches—(see formula (120),

and l_g = mean distance between pole-pieces and armature circumference in inches (see (124) and (125).

The mean area of the gap space for any armature facing poles opposite its outer periphery is given by the equation:

$$A_g = \tfrac{1}{2}(a_a + a_p) \times \tfrac{1}{2}(l_a + l_p) \quad . \quad (120)$$

where a_a = half perimeter of armature core, in inches.

For smooth cores, Fig. 58:

$$a_a = \frac{d_a \times \pi}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (121)$$

for toothed cores, Fig. 59:

$$a_a = \frac{d_a \times \pi}{2} + n \times q \quad . \quad . \quad . \quad (122)$$

d_a = diameter of armature core, in inches;
n = number of teeth;
q = depth of slots, in inches;
a_p = circumference of half the pole-pieces, in inches;

$$a_p = d_p \times \pi \times \frac{P \times \phi}{360^\circ} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (123)$$

d_p = diameter of bore of pole-pieces, in inches;
p = number of pairs of magnet poles;
ϕ = angle embraced by each pole;
l_a = length of armature core, in inches;
l_p = length of pole-pieces, in inches;

The mean length of the field path, in both gaps, according to Chapter 48, is—

For smooth armatures:

$$l_g = k_{13} \times (d_p - d_a) \quad . \quad . \quad . \quad (124)$$

and for toothed armatures:

$$l_g = k_{13} \times (d_p - d_a) + \frac{s \times q}{s + t} \quad . \quad . \quad (125)$$

d_a = diameter of armature core, in inches;
d_p = diameter of bore of field, in inches; } Figs. 58 and 59
s = width of slots, in inches;
t = width at top of teeth, in inches; } Fig. 59.
q = depth of slots, in inches;
k_{13} = factor of field deflection (see Table LVI. in Chapter 48).

* From the *Electrical World* (New York).

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Combining formulæ (120), (121), (123), and (124), and formulæ (120), (122), (123), and (125) respectively, the relative permeance of the air-gaps for smooth and for toothed armatures respectively is obtained.

For smooth armatures we have :

$$P_1 = \frac{A_g}{l_g} = \frac{\frac{1}{2}\left(\frac{d_a\pi}{2} + d_p\pi \times \frac{p+\phi}{360^\circ}\right) \times \frac{1}{2}(l_a + l_p)}{k_{13} \times (d_p - d_a)}$$

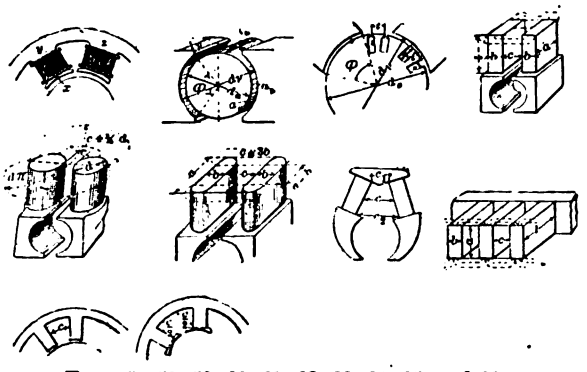
$$= \frac{\left(\frac{1}{8} d_a\pi + d_p\pi \times \frac{p \times \phi}{180}\right)(l_a + l_p)}{k_{13} \times (d_p - d_a)} \quad . \quad (126)$$

and for toothed armatures :

$$P_1 = \frac{A_g}{l_g} = \frac{\frac{1}{2}\left[\left(\frac{d_a\pi}{2} + n \times q\right) + d_p\pi \times \frac{p \times \phi}{360^\circ}\right] \times \frac{1}{2}(l_a + l_p).}{k_{13} \times (d_p - d_a) + \frac{s \times q}{s+t}}$$

$$= \frac{\frac{1}{8}\left(d_a\pi + d_p\pi \times \frac{p \times \phi}{180} + n \times q\right)(l_a + l_p)}{k_{13} \times (d_p - d_a) \times \frac{s+q}{s+t}} \quad (127)$$

For armatures revolving outside of a magnetic field (inner-pole type), in the denominator of formula (125) the order of the diameters d_a and d_p is to be reversed, as in this case d_a, the internal diameter of the armature core, is larger than the diameter of the field.



Figs. 57, 58, 59, 60, 61, 62, 63, 64, 65, and 66.

If poles are situated interior as well as exterior to the armature, the mean of the outer and inner gap areas has to be taken by applying formula (120) to the inner diameter as well as to the outer diameter of the core, and instead of $(d_p - d_a)$ the sum of the outer and inner gaps is to be substituted.

In case of armatures, finally, facing the poles in the axial direction (flat ring type), the gap area, if pole-pieces are used, is the mean of half the pole area and the ring area of the armature core, and if no separate pole-pieces are employed is practically equal to half the sectional area of the magnet cores. The mean length of the path is the difference between the axial pole-distance and the axial breadth of the armature core multiplied by the factor of field deflection.

(*c*) *Relative Average Permeance Across the Magnetic Cores* (P_2).—Since in dynamo-electric machines the magnet cores with their ends averted from the armature are magnetically joined by special "yokes," or by the frame of the machine forming the magnetic return circuit, the magnetic potential between these joined ends is practically = 0, while the full magnetic potential is availing between the free ends towards the armature. The average magnetic potential over the whole length of the magnet cores, therefore, is one-half of the maximum potential, and the average relative permeance, consequently, one-half of that which would exist between the cores if they had the same magnetic potential all over their length.

For the various forms of magnetic cores by means of formulæ (113) to (118) respectively, we therefore obtain the following relative average permeances :

1. *Rectangular Cores.*—The permeance between two rectangular magnet cores, Fig. 60, is the sum of the permeances between the inner surfaces which face each other, formula (114), and between the end surfaces which lie in the same plane, formula (115), and therefore the average permeance is

$$P_2 = \frac{a \times l}{2c} + \frac{b \times l}{c + b \times \frac{\pi}{2}} \quad . \quad . \quad . \quad (128)$$

where a, b, c, and l are the dimensions of the cores, in inches, as in Fig. 60.

2. *Round Cores.*—According to formula (117) we have in this case (see Fig. 61) :

$$P_2 = \frac{1}{2} \times \frac{d\pi \times l}{c + \frac{3}{4}d} = \frac{d\pi \times l}{2c + 1{\cdot}5\,d} \quad . \quad . \quad (129)$$

3. *Oval Cores.*—For oval cores, Fig. 62, the permeance path consists of two parts—a straight portion between the inner surfaces, and a curved portion between the round end surfaces. Combining, therefore, formulæ (114) and (117) we obtain :

$$P_2 = \frac{(a-b) \times l}{2c} + \frac{b\pi \times l}{2c + 1{\cdot}5\,b} \quad . \quad . \quad (130)$$

4. *Inclined Cores.*—If the cores, instead of being parallel to each other, are set at an angle, Fig. 63, the distance c in formulæ (128), (129), and (130) respectively has to be averaged from the least and greatest distance of the cores:

$$c = \frac{c_1 + c_2}{2} \quad . \quad . \quad . \quad . \quad (131)$$

5. *Multipolar Types.*—In the case of multipolar dynamos of p pairs of poles, the total permeance across the magnet cores is $2p$ times that between each pair of the cores. In calculating the latter, it has to be considered that while the permeances across two opposite side surfaces does not change by increasing their number, the leakage across two end surfaces is reduced—half of the lines leaking to the neighbouring core at one side, and half to that on the other side.

For rectangular cores, therefore, we have, with reference to Fig. 64 :

$$P_2 = 2p \times \left(\frac{a \times l}{2c} + \frac{\frac{1}{2} b \times l}{c + b \times \frac{\pi}{4}}\right) = p \times \left(\frac{a \times l}{c} + \frac{b \times l}{c + b\frac{\pi}{4}}\right) \quad (132)$$

For round cores, according to formula (118) :

$$P_2 = 2p \times \frac{d\pi \times l}{2(2c + {\cdot}6\,d)} = p \times \frac{d\pi \times l}{2c + {\cdot}6\,d} \quad . \quad (133)$$

and for oval cores :

$$P_2 = p \times \left(\frac{(a-b) \times l}{2c} \times \frac{b \times \pi \times l}{2c + {\cdot}6\,b}\right) \quad . \quad . \quad (134)$$

In multipolar machines, for c the smaller of either the mean distance between two magnets, Fig. 65, or twice the mean distance between magnet core and yoke, Fig. 66, is to be taken.

(*d*) *Relative Permeance Across Pole-Pieces* (P_3).—The amount of leakage across the end and side surfaces of the pole-pieces—that is, across all their surfaces not facing the armature core—depends upon the slope of the pole-pieces, and upon the design of the machine with reference to an actual iron surface (bedplates) near the pole-pieces.

By the principle of the magnetic potential the actual permeance, according to formula (112), in this case is also the "relative" one, as the magnetic potential between two pole-pieces of opposite polarity is unity.

The respective relative permeance for the various shapes of pole-pieces can, therefore, easily be deduced by means of formulæ (113) to (118), Chapter 38.

(*e*) *Relative Permeance Between Pole-Pieces and Yoke* (P_4).—According to the general principle of calculating relative permeances, the magnetic potential between pole-pieces and yoke is to be taken = ½, with reference to the potential between two pole-pieces of opposite polarity; for the yokes serve to join two magnet cores in series magnetically, and are therefore separated from the pole-pieces by but

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one electromagnet. If the yokes join the magnets in parallel, then they usually serve as pole-pieces also, and must be considered as such in leakage calculations.

Since the amounts of the leakages in the various paths are proportional to their permeances, in dynamos having an external iron surface near the pole-pieces, most of the leakage takes place between the pole-pieces across that external surface, and in such machines the leakage from the pole-pieces to the yoke is comparatively small.

The value of the relative permeance between pole-pieces and yoke for every individual case, consequently, is obtained by taking one half of the respective actual permeance as calculated from formulæ (112) to (118) respectively.

NOTE.—The end of Chapter 36, page 744, should read: "Prof. Forbes's logarithmic formulæ* heretofore employed," etc.

Formula (113), page 744, should read:

$$P = \frac{\frac{1}{2}(A_1 + A_2)}{c + \frac{a_1 + a_2}{2} \times \frac{\pi}{2} \times \frac{a}{180^\circ}} \quad . \quad . \quad (113)$$

In paragraph referring to Fig. 54, section (*e*), page 745, $y = \frac{a}{4}$ should be replaced by $y = \frac{d}{4}$.

In section (*f*) of page 745, read $c + \cdot 3\ d$, instead of $C + \cdot 3\ d$.

(To be continued.)

ON THE PRODUCTION OF ROTARY MAGNETIC FIELDS BY A SINGLE ALTERNATING CURRENT.†

BY LUDWIG GUTMANN.

Since the first announcements of Prof. Ferraris and Mr. Tesla, that rotation can be accomplished by employing two or more alternating currents of displaced phase, the question has been raised by many an engineer as to the possibility of producing a rotary magnetic field by the use of a single circuit, carrying the ordinary alternating current, instead of requiring three or more wires or several independent circuits. So far, it has been necessary to construct a special generator armature, the windings of which were rotated in a field of constant polarity, to produce two or more currents lagging in phase behind each other. To use the currents generated for establishing a progressive or rotary field, it was necessary to carry as many wires to the place of consumption as currents were employed differing in phase. Six years have passed, and quite rapid progress has been made in various directions. I wish now to bring to your notice a method of generating a rotary magnetic field by a single alternating current or its field, without condensers or choking coils. This is accomplished by a device brought out by me some three years ago. Its fundamental principle is hardly as yet appreciated; however, the World's Fair exhibits, as well as literature of late, show that the device has attracted attention, and that several engineers have approached the principle involved.

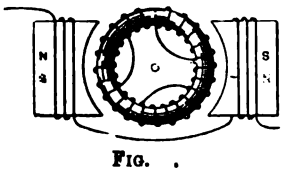

FIG. .

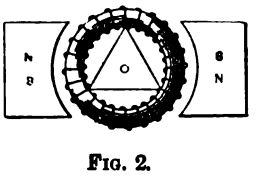

FIG. 2.

I wish to refer to my motor, and especially to its armature, described in 1891. Fig. 1 and Fig. 2 show the device. The former is principally used in the American patents, while the latter is given in the English patent of the same year. The novelty of the armature construction lies in a winding containing closed sub-circuits, and another point is that the closed circuits do not coincide in number with the poles of the field magnet. Before going into the action of this device, I will mention two simple experiments which are essential in order to understand the operation of this rotary magnetic field system.

If we have a closed coil moving in an alternating magnetic field, or better, between the poles of a field magnet as illustrated in Figs. 3 and 3A, energised by alternating

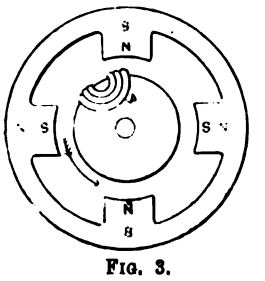

FIG. 3.

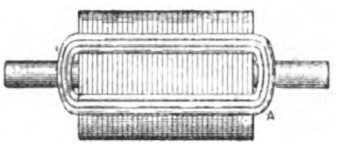

FIG. 3A.

currents; then the coil, A, will be repelled from the pole, owing to the secondary field which it establishes, so long as it cuts or is threaded by the lines of force of the field. The consequence is that it will rotate, and place itself between the north and south pole, Fig. 4, where it reaches a stable magnetic equilibrium, as I like to term it, because in this position it acts like a pendulum properly suspended, Fig. 5. Any motion imparted causes the pendulum to make a few oscillations and come to rest, and similarly any attempt made to move the coil into an energised field will cause it to be repelled, and after a few oscillations it will remain at rest between the poles. It is repelled in either direction, because as soon as it approaches a strong magnetic flux currents are induced in its windings and create an opposing field. The same coil can be in unstable magnetic equilibrium, Fig. 6, if it stands just in front of a pole, in which position it would act like a pendulum which is balanced with the weight above the point of support, Fig. 7.

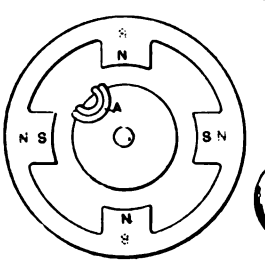

FIG. 4.

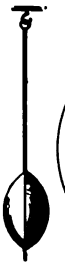

FIG. 5.

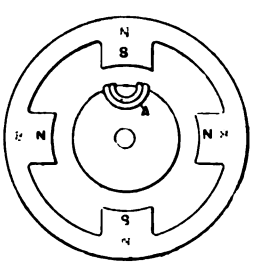

FIG. 6.

FIG. 7.

Both are in unstable equilibrium. The least motion to the left or right imparted to either will cause them to accelerate in the direction of the impulse, and to assume a position of stability, Figs. 4 and 5. In this position, Fig. 4, the coil is therefore currentless. This stable position is the natural position of synchronous motors in operation.

If such a synchronous motor is held behind the phase when rotating under load, a heavier current is induced in the spools which accelerate the armature and keep it in step. If, however, the motor runs in harmony, and suddenly a great deal of the load is taken off, then the armature has a tendency to go more quickly, but in this case opposing currents are generated in the windings which retard the speed of the armature and keep it back, to remain in step, or in stability.

Let us look into the device before us, and consider first its quality as a motor. Returning to Figs. 1 or 2, preferably the latter, which is simpler and easier to explain, we find that if we send into the field-magnet coil an alternating current, the armature will turn through a certain angle and stop. This motion depends upon the position of the three closed coils with respect to the two poles. This same device can itself be self-starting if we make the poles far enough apart and the energising current sufficiently strong, so that at the initial speed the armature is repelled at a certain rate. This initial speed changes with the number of poles, closed circuits, and alternations. Let us take the first case and examine it. If we try to rotate the armature (as I shall call it hereafter) in a field of alternating polarity, we induce currents in the closed circuits which establish poles, but these poles are alternating in

* Silvanus P. Thompson, 'Dynamo-Electric Machinery,' fourth edition, page 186."

† Paper read before the American Institute of Electrical Engineers.

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nature, and owing to the motion imparted, and owing, further, to the permanent connections in the winding, the poles move or travel with the latter. This accounts for the fact that if the field poles are close together the armature consumes power during its rotation through the alternating field; it acts as a dynamo, and does not start from a state of rest. If we impart by mechanical means an impulse to the armature, currents are generated whose sum has a variable and principally negative value. The armature makes a few revolutions and places itself in a stable magnetic equilibrium—viz., in such a position, symmetrical if possible, as not to generate any currents, and hence not to induce any reactionary* poles in the core. If, however, we impart to this armature a certain initial speed, which I shall call the critical speed, then it will continue to rotate, with a tendency to reach a certain fixed higher speed. This initial impulse may be given by

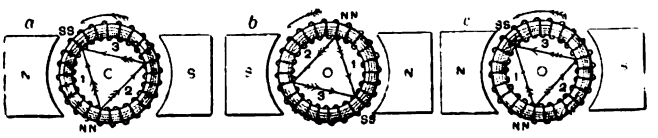

FIG. 8.

mechanical or electrical means. I shall not state the results as yet, but prefer to explore the action first, so that the same may be before us in various diagrams, and enable us to make any deduction desirable. First, let us assume that the armature rotates synchronously: it is evident that in order to have an armature with three close-circuited coils, interconnected as shown, rotate in one direction, we must have currents induced whose sum has a positive value—viz., two of the coils must do work, in the same sense, while the third coil is either without a current, or has a smaller current in opposite direction, so that the value still remains positive. For true synchronism, a close-circuited coil reaches within a half-period the opposite pole, and consequently our diagram for one revolution would look as follows (see Fig. 8).

The three diagrams, *a*, *b*, *c*, show the flow of currents and resultant poles. The close-circuited coil 2, diagram *a*, is at this moment generating opposing currents to the others; coil 1 is passing just in a front of a pole. All three induced currents combined are developing poles, as indicated, and rotating the armature in counter clockwise direction. The rotation being synchronous, diagram *b* shows the position of the armature when the polarity in the field has reversed; diagram *c* gives the position of the coils after the polarity has changed again. It will be noticed that the original position, as shown at *a*, has been reached again, and that the cycle will repeat itself. Without explaining these diagrams at this point, I wish to bring before you several other conditions, all of which will assist in reaching definite conclusions. Looking at the armature, we see that it has a symmetrical winding, and as long as these closed circuits do not coincide with the number of poles of the field magnet (contrary to all synchronous motors built heretofore), other working positions are possible. The operation will take place as long as the sum of the armature currents have a positive value,

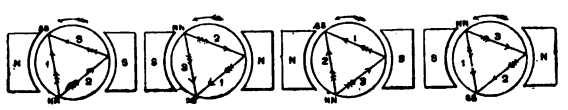

FIG. 9.

since as far as the rotation is concerned it is indifferent which of the coils are doing the work. Let us assume that the armature does not run at a synchronous rate, but at another fixed speed which may have a certain commensurable relation to the periods of the exciting field current, which speed I shall call the harmonic speed. Instead of showing the diagram with windings as in the first set, I have simplified them. In the following sets of diagrams, Fig. 9, I assume that the armature, on account of the load or other reasons, cannot reach synchronism, and that at each field reversal the position of the armature with respect to the field is the same, only the coils have changed places as indicated. You will notice that in this set of diagrams the armature, for each half period, makes one-third of a revolution only—namely, coils 1, 3, and 2 exchange positions with the change of polarity. Let us step at once to another speed, Fig. 10, which you will no doubt admit as possible—viz., let us assume that coils 1, 2, and 3 cannot arrive at synchronous speed, and that coil 2 reaches the position which 1 ought to occupy; it will be seen that, owing to the symmetrical position, it is quite indifferent which of these coils arrives at a given position required for harmonic operation. This will be clear to you by referring to the third set of diagrams, Fig. 10.

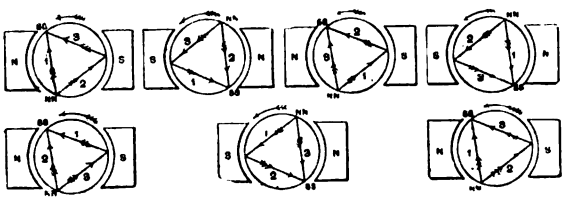

FIG. 10.

We are now enabled to compare three sets of diagrams, Figs. 8, 9, 10. The first set shows for this new type of synchronous motor that at synchronous speed the pole positions in the armature are practically stationary relatively to the coils and core and rotate with it. The second set shows that during a complete revolution of the armature the field has reversed three times—that is, an odd number of times—hence when the armature returns to its original position after a complete revolution, it finds the field magnetisation of reversed polarity. The magnetic field of the armature rotates in the opposite sense, one and a half times per revolution. In the third set, the armature makes but one-sixth of a revolution per half period, and the magnetic field of the armature in a complete revolution rotates three times in the opposite direction. This statement may be startling, and my argument, so far, may not be entirely convincing, as on close inspection it will be found that the armature poles have to do considerable jumping. I will now explain the performance of the rotary magnetic field of this armature in a four-pole field, where the changes occur far more gradually, leaving no doubt whatever as to the assertion made. Fig. 11 shows diagrams illustrating synchronous speed. By the aid of these four diagrams we can more easily follow the pole positions in the armature core, and find them stationary in it. Inspecting now Fig. 12, in which the armature speed is reduced, we are able to obtain a clear picture of the main subject under consideration.

FIG. 11.

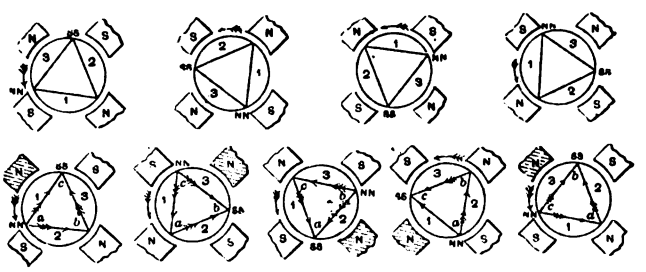

FIG. 12.

In this set of five diagrams we see five positions, which coil 1, for instance, occupies before it has made one-third of a revolution. Nevertheless, if we now look at the changing pole positions we can readily detect that they are progressively shifting, and we also see that they have made one whole revolution, and that in opposite direction to the mechanical rotation, or, in other words, the magnetic field would travel three time around the armature core during one revolution. In all armature diagrams described and to be described, the resultant of the magneto-motive forces of the armature currents is given only. To complete the picture showing everyone of the component magneto-motive forces acting, it becomes desirable to plot a diagram

* It is well to call the armature poles due to the armature currents, reactionary poles. The other armature poles are induced directly by the field poles, and contribute nothing to the torque.

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of force, Fig. 13. These components act like three variable concurrent forces, including an angle of 120deg. with each other. These forces we may represent as equal for the sake of convenience, as it does not influence the idea which we wish to illustrate. However, those two forces which are acting in the same direction are indicated by heavier lines.

Plotting the direction of the forces in order, as, for instance, in the last-named set of diagrams, Fig. 12, where the coils act in the order 1, 2, against 3; 3, 1, against 2; and 2, 3, against 1, we obtain Fig. 13 for one cycle. The three figures marked *a*, *b*, and *c* indicate the direction in which the three forces are acting in the three positions of one cycle or revolution. By drawing the resultant diagram of force from the predominating forces of each position, we obtain the accompanying figure, Fig. 14. These forces form a triangle, and the rotation resulting may be seen from the direction of arrows on the circumference of the surrounding circle. However, the reactive forces should be considered and represented separately to obtain the true picture, and we have to add them to find the total force applied and the manner in which all the forces are acting. We, therefore, repeat the resultant diagram, Fig. 14, and add the opposing forces at their proper places. This diagram, Fig. 15, shows that the reactive forces, shown by dotted arrows, also have a common centre, and that as regards time of maximum effect, they succeed each other in the direction of rotation of the armature, while they are acting in the opposite direction of the main force. If we now plot a diagram of these reactive forces alone, we obtain the smaller triangle shown, Fig. 15, inside the larger. It will be noticed that rotation is in the opposite direction, or, in other words, that in reality we have, with this disposition, to deal with two rotary magnetic fields in opposite direction; the useful work done will depend on the difference of the angular velocity of these two rotating fields and their relative intensity.

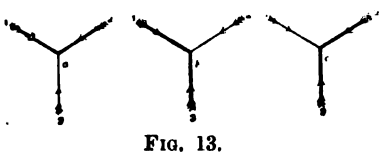

FIG. 13.

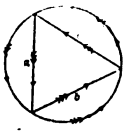

FIG. 14.

Looking now at the device as a generator, Fig. 12, we can account for the rotary magnetic field because we generate polyphased currents in the coils 1, 2, and 3. They operate together in the following order: 1, 2; 3, 1; 2, 3; 1, 2, etc. If rotated as shown, the coils will distribute three-phased currents over the armature, and this will be understood when examining into the flow of currents of the close-circuiting conductors which are here provided with arrows. At this particular harmonic speed it will be further noticed that the simple alternating field of force has the identical qualities as a polyphase energising field, as the poles in front of the close-circuited coil seem to be travelling (for the armature) in clockwise direction. This is indicated by the shading of the pole of same sign in front of the coil most powerfully acted upon in the five positions, representing one revolution for the field. The currents displaced in phase cause the armature to rotate harmoniously with the alternations, and prevent the armature from being easily thrown out of step.

Returning once more to the earlier diagrams, Figs. 9 and 10, we see that below synchronism there are two other speeds which are entitled to be called synchronous, because a certain fixed relation exists between the periods of field excitation and armature rotation. It will be evident that the greater the number of closed circuits, the greater is the number of harmonic or synchronous speeds in which the armature can operate. If the armature contains 10 closed circuits, and rotates in a two-pole field, it will be able to generate five currents, lagging 72deg. behind one another in phase, and would have at least five speeds which are synchronous, and the armature, owing to its peculiar construction, can operate at a slower speed than the synchronous speed as interpreted heretofore.

Looking at the device from a general standpoint, it will be clear that this particular armature construction embodies all the weak points of a synchronous and all the strong points of the polyphase motor. The weak points are: (1) That the machine will not start from state of rest in the form shown, because in Figs. 1, 2, and 12 the coils act on one another differentially, and have a variable and negative value; they are in magnetic stability when at rest, hence no rotation can result. (2) The device has a small starting torque when rotated, owing to the differential action of the coils, which cause, with a small number of closed circuits, strongly oscillating or jumping poles until a harmonic speed is reached. (3) The device when in rotation is not reversible by simply changing circuit connections.

The strong points are: first, that the motor develops polyphased currents in its own windings; second, that therefore it is more difficult to pull it out of step as it has the capacity to stand what I would term magnetic slippage.

Let us assume that a certain coil, which should reach a given point to run harmonically, remains behind owing to a slower motion of the armature; in this event the coil ahead has to perform the function at the expense of a slightly heavier current. The loss of revolutions due to this action may be comparable to the slipping of a belt over a pulley. However, there is also a limit to the slipping. The armature should have some harmonic speed with respect to the alternations. Should it fall below the lowest harmonic speed, then it will come to a standstill just like any other overworked synchronous machine.

Synchronism in a motor means nothing more or less than a magnetic flexible clutch, which may be represented mechanically as follows: The old fashioned non-starting synchronous machine having equal armature coils and field poles, can be compared with the arrangement shown in Fig. 15A, giving side view and elevation. The disc 1 is provided with two projections; 2, imparts rotation to shaft 4 by means of the flexible arm, or spring 3, which

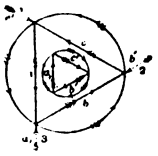

FIG 15.

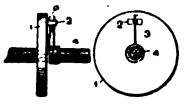

FIG. 15A.

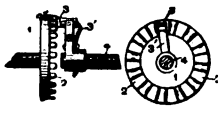

FIG. 15B.

enables the shaft 4 to be slightly behind or ahead of disc 1. However, if the work put on shaft 4 is in excess of the strength of spring 3, then it will break, and shaft 4 will speedily come to a standstill.

In contrast to this older form of synchronous motors stands the new one, which forms the subject of this paper, and the machines operated by bi- or polyphased currents. The mechanism for showing magnetic coupling for these latter types may be represented by Fig. 15B. In this case, 1 represents a crown wheel, the teeth marked 2; into these teeth meshes a catch, 3, in a flexible manner, which catch is connected rigidly to shaft 4. Within the range of normal work catch 3 would remain fixed between the two given teeth, but if the shaft 4 is overloaded, the flexibility of catch 3 will cause it to yield and pull out of its position, drop in between some other two teeth, and continue to operate, but at a slower speed. The greater the excess of work the greater will be the slippage, and the more teeth will be jumped by the catch 3 in every revolution of disc 1. For the synchronous motor herein described, the overloading to the extent that it cannot reach the lowest harmonic speed, would be equivalent to the breaking of spring 3.

It will be remembered that Prof. Ferraris always, and Tesla sometimes, obtained a rotary magnetic field and rotation by influencing one coil carrying a primary current, by another at right angles thereto carrying secondary currents. Here we have two phases from a single source, Fig. 16. To obtain a multiple of phases we may take two or three iron cores, A, and surround them with coils, B, like the links of a chain, Fig. 17, so that the secondary coil of transformer 1 is the primary of transformer 2, and so on; or we may design a special core for a transformer, and create a rotary magnetic field by applying to one coil

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a primary current from the line, and to another coil a secondary current from a transformer, whereupon, by the rotary field obtained, polyphased currents may be taken through other coils on the transformer. These methods have, however, one drawback, and that is that the phase will change more or less in lag with difference in load, while, for many purposes, it is most essential that for efficient working the phase should remain at the same constant angle. This desideratum has been accomplished by the device under consideration, and any suitable number of currents lagging in phase may be obtained from a single alternating current.

To obtain a rotary magnetic field in or by a stationary body, at least two electric or electromagnetic forces of definite phase relations acting at an angle to one another and changing at periods harmoniously are essential requirements.

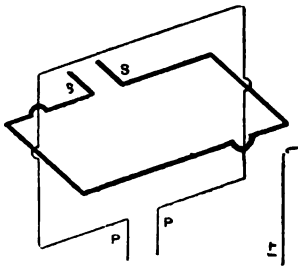

FIG. 16.

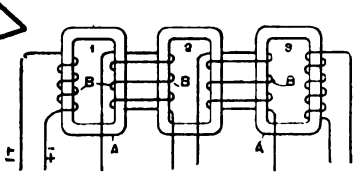

FIG. 17.

If, however, we allow the body, or part of the same, to be movable, we may substitute mechanical rotation primarily as an adjuster of the periodicity and phase of one of the two forces. The fundamental relation between the two forces must in this case also be the same as in the other—namely, they must work in harmony—and the periodicity and phase determines the periodicity and phase of the other of one force. If the second force is a current, it must be one of the same period or some harmonic of that period; if it is rotation, it has also to be synchronous or harmonic. We can now clearly understand why, when rotating the armature, Figs. 1 and 2, in an ordinary alternating-current field we have no system of polyphased currents and no rotary field, simply because the armature rotation does not stand in any relationship whatever to the alternations; but as soon as the speed does so, there are generated polyphased currents lagging in phase at a field angle, and a rotary magnetic field.

There is a difference whether the armature is influenced by a single alternating current, or by several, causing themselves a rotating energising field. Nevertheless, in either condition the armature is in magnetic stability, and this state is the reason that it remains stationary in the first case, and that it rotates in the second. The reason that the motor starts in the second case is evidently because the inducing magnetic field is itself rotating in the stationary field-magnet core. As said before, it is considered necessary for the proper operation of the armature for giving maximum torque that, if placed in an alternating-current field of force, the armature rotation should have a definite relation to the alternations. Up to the publication of this device some three years ago, synchronous motors had as many armature coils as field coils, and hence to obtain the value of the synchronous speed, all that was necessary was to divide the alternations of the armature current, n, by the number of field poles, p, of the magnet employed. But if the number of armature coils are not the same as the field poles, then the speed may vary from this synchronous speed, and a modification is thought to be necessary. We would have to find the smallest common factor between field poles, p, and armature coils, p^1, with which we have to divide the number of alternations to obtain the value of the lowest synchronous speed while the conditions of slippage may allow for the lowest harmonic, the value $\frac{n}{pp^1}$.

It will now be clear that motors can be designed having any desired variation of speed, and have defined synchronous speeds or approach the indifferent relation. I wish it understood that I do not intend to treat the subject in all its details, and I am especially reluctant on the ground of having carried on but few experiments.

The few diagrams presented do not disclose many conditions of those possible. They show only one or two facts of conditions which frequently are of a complex nature. Evidently, the rotary magnetic fields in the device under consideration may have altogether different speeds from those shown in the diagrams; also, that the magnetic field may rotate with and ahead of the armature; and, lastly, the speed of rotation of the rotary field of the armature may be synchronous and opposite in direction to its rotation.

The device has been given in form of a diagram, and as it has been described as not self-starting, I wish now to state that it becomes self-starting as a series, a shunt, or an induction motor in a field of single phase or polyphased alternating currents. Fig. 18 represents one of the earliest forms which have since been simplified to a considerable

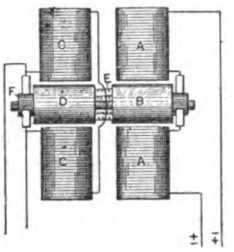

FIG. 18.

extent. The part A B represents here a simple series motor, whose armature, B, may be any Gramme or ring type, open or closed coil winding; the part C D may be similarly constructed. Both armature windings, B and D, are connected electrically by four wires, E, at points of equal distance, which number of conductors, E, may be reduced or increased, depending on the number of phase currents desired. Now send an alternating current into the series motor, part A B*, then the armature will start from state of rest and will send current impulses into the D part winding, which becomes the more regular the more the armature has approached synchronous speed, where bi-phase currents will be established therein; these react on the field-magnet core, C, and for the purpose of maintaining the armature in this synchronous speed, the commutator, F, is applied to rectify the polyphase currents, which continuous current may be used to energise the magnet, C.

The fundamental principle disclosed opens to us a very wide field for work. Not only are we enabled to construct motors almost as cheap and simple as continuous-current motors, but there is in this principle involved the germ for the ideal distribution of power, inasmuch as we are enabled to collect the polyphased currents generated, or commutate them immediately at will.

Finally, I wish to call your attention to the fact that the last figure is in reality a motor generator, and it is therefore evident that the electrical energy supplied need not all to be transformed into mechanical power, but that a portion may be utilised in one of the modified forms named above.

TRANSFORMER TESTING.†

BY EUSTACE OXLEY.

A transformer of the present day is an exceedingly efficient piece of apparatus, even when operated at small loads, but the combination of a large number of small transformers, with their primaries connected to the mains 24 hours out of 24, and with their secondaries open 18 hours or more out of 24, is a source of loss and inefficiency which has for a long time provided direct-current, low-pressure advocates with their main argument against the employment of the alternate-current system.

If consumers could be provided with a suitable switch for opening the primary circuit of their transformers when their lights were not in use, and at the same time could be relied upon to do so, this loss of power might be avoided;

* Preferably so that no reaction takes place from part D.

† *Electrical World* (New York).

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otherwise, it would seem that the so-called "banking" of transformers, in connection with a low-pressure distributing network, was the only remedy.

In a system where every consumer is provided with a separate transformer, this loss at no load is of great importance in determining the all-day efficiency, and it is therefore advisable to test all transformers before they are sent out from the central station to be connected with the mains. Tests should be made of insulation, magnetising current, core loss, efficiency, and drop.

Insulation.—The insulation between the coils and between the coils and the shell should be able to withstand the application of P.D. equal to twice the primary voltage at which the transformer is intended to work; thus, a transformer intended for use on a 1,000-volt circuit should be tested for insulation between these parts, with a pressure of 2,000 volts.

Magnetising Current.—Measurement should be made of the magnetising current—*i.e.*, the current which passes through the primary coil when the secondary circuit is open.

Measurement of Core or No-Load Loss.—The "no load" loss is the power absorbed by the primary when the secondary circuit is open. There are several well-known methods of measuring the power taken up in a transformer, but they are not all, however, adapted for use in the workshop. Those commonly employed are the "three voltmeter" method of Prof. Ayrton and Dr. Sumpner; the "three-ammeter" method (a modification of the first by Prof. Fleming), and various "wattmeter" methods. The first two are very similar, the difference being that in one case you measure volts, and in the other current; in both a single instrument may be used to take the three readings. Eminent authorities have advocated the use of the wattmeter for measuring power in alternate-current circuits; however, workshops are seldom provided with a suitable wattmeter for the purpose. As the three-ammeter test can be made with an ordinary Siemens dynamometer and a voltmeter capable of measuring the volts on the low-pressure side of the transformers, it is perhaps most generally employed. Although this method has been frequently described, it is possible there are some who are not yet acquainted with it, so perhaps a short description would not be out of place.

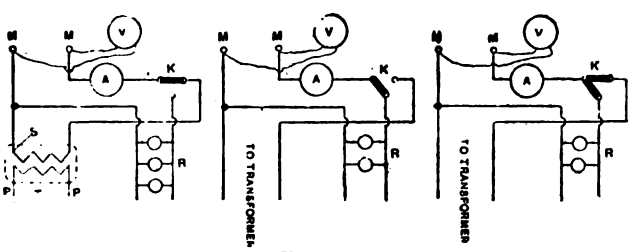

FIG. 1.

To measure the "no load" loss in a transformer, arrange things as shown in Fig. 1, where M M are the secondaries of another transformer providing the proper voltage, A the dynamometer, V the voltmeter, T the transformer under test, P the primary, and S the secondary coil; R is a non-inductive resistance, such as incandescent lamps; and K a three-point switch, conveniently made with mercury cups and copper connecting-pieces. The primary circuit is left open during the test. The voltage must be kept steady and at the proper value. Then if C is the current which flows through the transformers alone (when K is as in Fig. 1), and C_1 is the current which flows through the inductionless resistance, R, alone (when K is as in Fig. 2), and C_2 is the current which flows when the transformer and inductionless resistance are placed in parallel with one another (when K is as in Fig. 3), and V is the voltage, read by the voltmeter, then the power in watts absorbed by the transformer will be

$$W = \frac{V}{2\,C_1}\{C_2^2 - C^2 - C_1^2\},$$

the greatest accuracy being when C is made equal to C_1.

Efficiency Test.—When it is required to test the efficiency of a transformer at different loads, taking measurements on the low-pressure side, two similar transformers are needed. The primary coils of the two transformers are connected together, and measurements taken of the power taken up by the secondary of the first and that given out by the secondary of the second. The loss is then divided between the two transformers, and their efficiency determined. Dr. Sumpner has given a method for measuring the iron and copper losses in a transformer by means of a single wattmeter. It consists in measuring the watts taken up by the secondary when the primary circuit is open; this gives the "no load" or "core" loss, then the secondary is short-circuited, and the power measured absorbed by the primary when the full-load current is passing in the secondary. This gives the "copper" losses, and adding these two together gives the total losses in the transformer.

A method of finding the efficiency of good closed magnetic circuit transformers at all loads is to calculate the $C^2 R$ losses at different secondary loads, and adding to this the "core" loss, thus getting the total losses at different loads, from which an efficiency curve can be plotted. The "core loss," which is constant at all loads, may be got by multiplying the apparent power absorbed at no load by O S. This last figure is the value of the power factor at no load, as determined by Prof. Fleming after an exhaustive series of tests on transformers of different makers.

Regulation.—The drop in the volts of the secondary circuit with increase of load should be measured, the "total drop" being the difference between the secondary volts at no load and full load. This drop of voltage is due to resistance in the primary and secondary coils and to magnetic leakage. It is, of course, desirable that transformers for use on lighting circuits should have as small a drop as possible.

EXPLOSION IN EUSTON ROAD.

The daily papers have this week contained reports of an explosion which occurred a few minutes after midnight on Saturday, between Endsleigh-gardens and Gower-street, on the south side of Euston-road, whereby about 40 yards of pavement were displaced, and the cover of a large manhole, with several flagstones, was blown into the air. Two pedestrians who were passing at the time were injured and had to be conveyed to University College Hospital. They were there found to be suffering from the effects of a severe shock. An inspection of the scene of the disaster was made by the electrical experts of the St. Pancras Vestry. It is supposed that an escape of gas reached the electric wires which pass under the pavement and so caused the explosion.

Major Cardew has made an inspection, on behalf of the Board of Trade, of the scene of the explosion. Mr. Pycraft, chief clerk of the electricity department of the St. Pancras Vestry, stated, a few evenings ago, that nothing definite was yet known as to the cause of the explosion. He said it was curious that on January 12 last a similar accident took place in Endsleigh-gardens, about 100 yards from the spot where this explosion occurred. The officials do not think that the explosion could have been caused by sewer gas. That it was due to an accumulation of coal gas, however, they consider very probable. An inspector says that he reported an escape of gas in the immediate neighbourhood about a fortnight ago. The officials think, too, that the frost may have had something to do with the matter, two similar explosions having occurred during a frost last winter.

Mr. J. T. Baron, M.I.E.E., the chief engineer to the Vestry, informs us that within 20 minutes of the explosion he noticed a smell of coal gas on the spot.

Major Cardew, inspector of the Board of Trade, has written to the vestry clerk, stating that the Board will hold an enquiry into the matter. The enquiry is to be held at the Vestry Hall on Thursday next, commencing at 10 a.m.

Electric Lighting in Switzerland.—The local authorities of Altdorf propose to expend £2,000 on a central electric lighting station.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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YEAR GONE—YEAR COME.

A HAPPY AND PROSPEROUS ONE TO ALL!

In that memorable prose epic, "The Pilgrim's Progress," John Bunyan has not given a particularly attractive character to Mr. Facingbothways, whose nature it was to metaphorically "sit on the fence"; yet in many respects this gentleman was a most estimable individual when he lived up to the literal significance of his name. He had a still more worthy ancestor called Janus, who reached the dignity of Roman godship, and rivalled the Siamese twins in the number of his heads. The latter, as most of us remember from our school days, were turned in opposite directions, so that their owner could look forwards and backwards at the same time: and the same kind of pastime is what we all try to indulge in at the opening of Janus's month—the opening, too, of our New Year, if not that of the Romans.

Whilst, however, it is good to emulate Bunyan's puppet in so far as his name is concerned at this particular season of the year, there is no occasion or need to speak with an uncertain voice, and "trim the sails to every favouring wind," when abstract principles and their practical application to electrical work come up for discussion, in the way that they are somewhat prone to do just now. Like Janus, we face both ways—we

> "Look back, look on: for midway now we stand
> 'Tween two sweet seasons—past, and that to come";

but it is only for the purpose of guiding the future by the failures of the past, of gauging possibilities, expectations, and hopes. It is well for healthy humanity in this respect that we live rather more in the future than in the past, and most of all in the present.

Looking backwards, what is there to criticise, to blame, or praise? The past year has been pre-eminently one of commonplace hard work, with the usual concomitants thereof—viz., some amount of profit, and a healthy feeling throughout the entire industry, just as in the individual a clear conscience and sound mind and body are promoted by the same means. No small thankfulness may be felt and expressed at the, comparatively speaking, pure air which electrical enterprise has breathed of late. The days of ill-starred and even fraudulent speculation have departed, it is to be hoped, for evermore, and the efforts of all are now directed towards legitimate trading and hard, steady work rather than loose gambling with worthless counters.

The abundance of work, even though not very remunerative except when large or numerous contracts are secured, has, however, brought into the field an enormous amount of competition, not merely between firms properly equipped and experienced, but also from those who cannot by any stretch of imagination lay claim to the title of "electrical engineer." Wherever central supply stations have been erected or even proposed by local authorities or private interests, there has at once sprung up a host of installation firms anxious to undertake wiring jobs at any price so long as they obtain the work, and are allowed to put up an elegantly

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enamelled signboard stating that the "electric lighting is by John Smith and Co. *All work guaranteed.*" The nature of a guarantee is in such cases too often rather more dubious than the qualifications or ability of the advertiser to carry out the work in a proper fashion, but the customers who employ firms of this stamp are really not altogether to be pitied or even enlightened as to the expense and danger of giving a free hand in wiring their premises to the nearest sanitary engineer or registered plumber. If a firm allows itself to take up work of a highly skilled nature without the least qualification or special care, any guarantee of efficient results given to customers can hardly have much more value than the paper upon which it may be written. We do not, of course, emphasise this point from any jealousy of the new-comer; it is an excellent sign of healthy trade when plenty of competition exists, because it shows that there is a strong demand for electrical installations, so long as fair prices rule with good work. Undercutting by electrical firms properly so-called, in order to get mere numbers of jobs, cannot, however, be too strongly deprecated; whilst the entry of unqualified workers—the gas-fitter and bell-hanger whose ideas of a good joint are two wire ends twisted together, and who prefer staples to casing because they are cheaper—into the field of installation work affords even stronger ground for remonstrance.

The tendency of both these evil courses is to bring electric lighting most unfairly into disrepute: the work is scamped, bad material is used, and worse labour. The consequence is that breakdowns ensue, and the customer is put to endless expense in remedying matters. It might be thought that the day for jerry work had long passed by, that the fire insurance interests were by now sufficiently awake to the importance of care in accepting such risks, and that the supply companies or central-station authorities would also preclude by their compulsory tests the possibility of bad work. The greater competition grows, the more likely, however, is the danger to continue, and it is to be feared that there is even to-day as much tendency as ever towards want of common honesty in purpose and effort throughout installation work. Customers are too often tempted by low prices to pass over the firms of repute (of whom we are glad to say there are very many) and give orders to Tom, Dick, or Harry, who quote a figure perhaps twenty-five or thirty per cent. less in order to get the work at a loss, to be made up by the "extras" and commission here, there, and everywhere.

It is somewhat with a feeling of relief that one turns to the electrical manufacturing interests: these may be said to lie now in the hands of a few, perhaps not more than a score all told, but their products are sound and reliable throughout. A firm of any importance in the manufacture of electrical appliances depends essentially upon its own good name and repute: its apparatus is designed and built to give lasting satisfaction, and this good result has been secured in proportion as the chief part of such business has become concentrated in the hands of a few. This sentiment of working for permanent effects would benefit the electrical trade enormously were it also to permeate the smaller workers, so that every man engaged in it might feel that his humble share of the whole task, however small, could be no better done.

Just as the installation firms have found plenty to do during the past year in the branches and twigs of each electric supply tree, so also the large manufacturing interests have been busy in the trunks and roots—in equipping central stations throughout the country, either for local authorities or private interests. Hardly a week has passed by without the completion and formal opening of some electricity supply central station being chronicled in our pages: and no small importance is to be attached to the fact that the great majority of these have been carried out by municipalities themselves. No stronger proof could be offered of the absolute confidence now felt in the use of electric energy as a means of obtaining artificial illumination, when public bodies thus engage in its development not merely for the lighting of houses and other interiors, but also for their streets and roads—a far more serious matter, since the public service is thereby involved.

So far, our remarks have dealt more particularly with electric lighting progress, because, unfortunately, but little can be said as to any developments in the use of electric power. The past year has seen the equipment and opening of the Douglas and Laxey electric line, and the projection of others; but so long as tramway enterprises generally in this country stand on so "impossible"—to use a French expression—a basis, little progress can be expected in electric traction upon our streets. The various "special" lines — the underground electric systems projected in the Metropolis, the elevated lines, etc.—are no further forward to-day than they were at this time last year; and this also must be ascribed to financial causes rather than any conceivable defects or want of development in electric traction, just as its use on street tramways is lacking because of the ridiculous Tramways Act, and the prejudice amongst the ignorant against an overhead trolley wire.

Applications of electrical power in general are, it must be said, but little more numerous now than a year ago: isolated plants have been erected and are most successfully at work, whilst in a few places—as, for instance, at Manchester, where a continuous-current system is employed—there are scattered examples of power uses employing electric motors for such purposes as hoisting, packing, etc. The want of a really suitable alternating-current motor, which can be relied upon to work under similar conditions and with equal economy, is still very marked, though great advances have been made, and, thanks to the Oerlikon factories, at least something of the kind is now available.

The tendency throughout the past year in regard to the generating plant of an electric supply service has been very markedly to take advantage of all possible appliances or methods which afford greater economy in the cost of developing energy, and many notable improvements have been suggested and brought into actual use. Not the least important

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of these includes better methods of using town refuse and cheap generator gas for effecting an economy in the cost of fuel—by no means a small item in the total expenses per unit generated: and it seems likely that still greater developments in this direction will be seen during the year now begun.

Taken as a whole, 1894 has been an "average" period: it has brought steady progress all round, if not the remarkable leaps and bounds characteristic of previous years, and not altogether to be desired in comparison, any more than the individual man will benefit physically from a "hunger and a feast" so much as a regular course of plain living. Some of the tangible results of the year, as evinced by the reports furnished to us from the principal firms engaged in the industry, may be gathered from the following paragraphs, wherein we abstract, as usual, a summary of work done and contracts carried out:

Bennett and Druce.

It is gratifying to learn that this Preston firm, notwithstanding an existence of only slightly over 12 months, have done a large amount of electrical work, especially in the North of England. The firm make a speciality of millwork, and much reliance seems to be placed upon them for installations of this nature. They found business fairly good, but report that prices have been low owing to the keen competition in the trade. During the 12 months they have installed about 4,700 lamps, with 20 arc lamps and 15 dynamos (one being a 78-kilowatt machine), three steam-engines, three gas-engines, and one battery of accumulators. About two-thirds of this number of lamps have been erected in mills. One of the characteristics of Messrs. Bennett and Druce is that they do none but the very best class of work.

Bolling and Lowe.

This firm report that in the iron, steel, and allied industries the past year opened with bright prospects, but that they only lasted for a short time, and then business lapsed into its former languid condition. There is a plethora of gold and silver in Europe, but it is in the less civilised parts of the world that development is most needed, but they have not sufficient reserves of their own to purchase from us for cash. Business is limited to the "necessity trade" that exists, for no other name can they give to the demand now ruling, which only represents the completion of work commenced, and the replacing of worn-out material. It must be evident that the continued deplorable depression in our agriculture greatly tends to diminish the home orders for the iron trade. In the United States the McKinley tariff has been amended, but it has hardly given any benefit to the English iron and steel trades. Our chance of business in the States is diminishing day by day on account of their cheapened means of production. There exists a feeling that when the war between China and Japan is over it will lead to a development of trade in these two countries, especially China. They believe this will be the case, but not for a considerable period. Our railways are owned by companies whose maximum charges of conveyance of passengers and goods are fixed by Acts of Parliament. Reductions in these rates, however much wanted, cannot be demanded as a right. They may be granted by courtesy of the respective companies. Under such conditions it can hardly be wondered at that we pay between 30 to 50 per cent. more than continental people, whose lines generally belong to the State. The light railways question has lately been taken up strongly in the Press, and is attracting great attention, but an early development of the project will be deferred, as the Board of Trade is prevented by its regulations from facilitating progress without reference to Parliament and consequent delay. Cheap road railways—£2,000 per mile—are more likely to meet urgent necessities, whereas light railways would in many respects, in the first instance, be more of a convenience than a commercial success. The fact that prices of iron and steel in 1894 have barely shown any variation in face of decreased exports must be taken as a most encouraging sign, and they can hardly believe that when a change does take place it will be other than an improvement.

Browett, Lindley, and Co., Limited.

Among the most important contracts carried out by this company during the past year may be mentioned the supply of nine engines and complete steam-piping for the Ealing electric lighting station; one 250-h.p. compound vertical engine for extension of Derby Corporation electric light station; one 100-h.p. engine for the Prescot station (the second extension with the company's engines); one 500-h.p. compound engine for extension of the Sheffield station; the whole of the engines (horizontal compound) for Southport electric lighting station; the engines for the Salford station, consisting of three pairs of horizontal side-by-side Corliss engines (200 h.p. each pair), with condensers; and engine for Aberystwyth station. Besides the above the company have been extremely busy in all departments, having made a great many engines for smaller installations, such as mills, collieries, and ships.

Brush Electrical Engineering Company, Limited.

The works of this important company, both in England and Vienna, have been fully occupied during the year, the contracts upon which they have been engaged including all classes of work in connection with electric lighting, both for private installations and central stations. The company report a very large increase, not only in the number of men employed in their works, but also in their outdoor contract department, where they have had large gangs continually employed both in putting down central-station work and in laying and extending mains in various towns. Extensions in central-station plant have been carried out at Huddersfield, Sheffield, Bournemouth, and Hastings, while central-station contracts at Hanley, Worcester, Lancaster, Leicester, and Coatbridge have been completed during the year. The company have supplied electrical plant for Bolton and the Great Northern Railway Company's station at Holloway, whilst the electric lighting of the Industrial Exhibition at Earl's Court last summer was also effected by plant of the company's manufacture. The company are at present engaged upon the Dover, Wandsworth, and St. Luke's town-lighting contracts, as well as upon the engines for the Clerkenwell station, and extensions at Bournemouth, Leicester, Worcester, Hanley, and other places. The orders received during the year include some of the above-mentioned town-lighting contracts, and, in addition, a complete installation at Malta, and the supply of plant for the London Exhibitions, Limited. Among the more important orders which have been completed in the way of isolated installations may be mentioned the lighting of Arundel Castle for the Duke of Norfolk;

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Battenhall Mount, Worcester, the residence of the Hon. Percy Allsop; High Tree Mansion, Redhill, the property of Mr. M. Marcus; and The Grove, Harefield, belonging to Mr. George Webster. The company have now in hand a large arc lighting plant for the Leith Docks Commissioners, and the lighting of the public library and Town Hall, by means of dynamos and gas-engines, for the West Ham Corporation. With regards to contracts abroad, the company's works in Vienna have recently supplied direct-current plant for the central stations of Wolfsberg, Riod, Zara, Schönlinde, Kitzbühel, Sternberg, Ujhely, and Risenstein, in Austria-Hungary; whilst in France, Mordey-Victoria alternators have been installed in the towns of Montargis, Riez, and Voroppe. In Australia, the company's branches at Sydney, Melbourne, and Adelaide have carried out important works, including the supply of plant to the Broken Hill Proprietary Company and the Rockhampton Coal and Gas Company; the lighting of the Hotel Metropole, Sydney; of the Hobart Exhibition; and of the sugar mills in Queensland. Among other foreign orders may be cited the supply of generating plant for the lighting of the Dutch State Railway station at Flushing, alternating-current power-transmission plant for Switzerland, projectors for the De Beers Mines Company, and the extension of the town-lighting station at San Carlos do Pinhal, Brazil. One of the interesting features of the company's record during the year has been the entire lighting of the Hastings sea-front by a large number of Brush alternating-current arc lamps. The result of this undertaking, which is, we believe, unique in the annals of alternating-current lighting, has called forth expressions of warm approval from many qualified judges. The Brush-Vienna arc lamp has also been put on the market since a year ago, and the headway it has made has been of the most gratifying description. While this lamp is suitable for either direct or alternating currents, it has proved itself a peculiar success with the latter, and the company have been overwhelmed with orders for its supply both at home and abroad. The Brush-Vienna dynamos, which were just making for themselves a place in Great Britain 12 months ago, appear to have found much favour in the eyes of users of electricity, if an opinion may be formed from the numbers which the works have been called upon to construct. Lamp-holders, plain fittings, volt and ammeters, are now among the manufactures of the company, and it is anticipated that the high-class workmanship and moderate price that are characteristic of these goods will secure for them a large and increasing demand. The company have now taken the sale of their incandescent lamps into their own hands, and have just issued a new price-list giving a description of the various types which they manufacture. These lamps are articles of every-day use, and the Brush Company, with 10 years' experience at their back, and the best and latest machinery in their works, feel in a position to furnish a supply whose quality will command the confidence of the general public.

Clarke, Chapman, and Co., Limited.

Judging from the formidable list sent to us of installations put up during 1894 by Messrs. Clarke, Chapman, and Co., of Gateshead-on-Tyne, the company have had a large share of important electrical work both on ship and shore. This is a satisfactory fact, but it is even more interesting to learn that the prospect for the present year is much brighter than that obtaining 12 months ago, the company having in hand a considerably greater amount of work. Among the important ship installations carried out may be cited those on the steamships "Duffield," "Aco," "Fontabelle," "Maroa," "Carlisle City," and the "Duplex"; four for W. Dobson and Co., Walker-on-Tyne; three for Sir W. G. Armstrong, Mitchell, and Co.; one for R. Stephenson and Co., of Hebburn; the "Glenfarg"; one for Short Bros., of Sunderland; a dredger for W. Simons and Co., of Renfrew; the "Turkestan," "Amelia," "Nestor," "Ixion," "Tantallus," "Johannesburg," "Anglian," "Fort Salisbury," "Powerful" (temporary lighting), "Alleghany," "Merionethshire," "Cleopatra," etc. The principal installations on land include the house of Mr. Fred. J. Scott, North Shields; the colliery of the Crown Preserved Coal Company, Cardiff; the vicarage of the Rev. J. F. Anderson, Coldstream; shipyard of Short Bros., Sunderland; colliery of Earl of Durham; the iron-works of the Seaton Carew Company, West Hartlepool; and the works of Tilghman's Sand-Blast Company, Sheffield. Apart from these, electric cranes have been erected at the works of Swan and Hunter, at Wallsend, whilst special electric galvanising plants have been laid down at the works of Sir W. G. Armstrong, Mitchell, and Co., Elswick; the Naval Construction and Armaments Company, Barrow-in-Furness; Hanna, Donald, and Wilson, Paisley; Palmer's S. B. and Iron Company, Jarrow; and H. J. Waterston and Co., Sunderland. Leaving aside the above-mentioned, Messrs. Clarke, Chapman, and Co. have supplied some large generating plants and switchboards for Messrs. Swan and Hunter, Wallsend, and a number of combined engines and dynamos and belt-driven dynamos for installations not carried out by them, as well as a number of search-light projectors of various types, etc. Amongst other important installations at present in hand may be mentioned H.M.S. "Powerful," "Juno," and "Doris."

S. Z. de Ferranti, Limited.

The volume of business transacted by this company during 1894 was a distinct improvement on the previous year. The trade in continuous-current meters has remained steady, and the company now number on their books the whole of the direct-current supply stations in England, the demand for meters during December being particularly brisk. The company have also been engaged in developing their alternating-current meter, which has lately been adopted by several supply stations, owing to the extreme accuracy and power of starting even with large-size meters with an 8 c.p. lamp. The supply of the whole of the electrical apparatus for the Portsmouth electricity station was also entrusted to the company, and included the provision of two 212-kilowatt slow-speed direct-coupled alternators, being the first of this type of plant erected in England, and a number of converters of the change-over and of the automatic type, the main and supplementary switchboards and the whole of the arc lighting plant being operated by their system of motor commutators. The company have supplied during the year a number of high-pressure dynamos, including two of 120 kilowatts, each direct coupled, for the central station at Caen; a 212-kilowatt extension plant for Portsmouth; a 300-kilowatt extension plant for Sheffield; and further dynamos for the British Insulated Wire Company, etc. Among the dynamos now on hand are the Edinburgh machines and a 100-kilowatt direct-coupled slow-speed dynamo for Islington. The company's system of running arc lamps by rectified current has proved a great

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success, and plants of this type are now running at Cardiff and Portsmouth, and are on order for Blackpool, Prescot, Tunbridge Wells, and Islington, and Edinburgh, and several important contracts for this apparatus are on the point of being concluded. The company have also supplied the high-pressure switchboard for Salford, and have now a similar one in hand for Edinburgh. The company have good orders on hand to keep them going for some time, and there is every indication of this year being one of the busiest they have had.

Dorman and Smith.

Extremely busy during the year is the keynote of the report of this Salford and London firm. The supply of main switchboards for central-station and isolated plants has so largely increased as to necessitate an immediate extension of the factory where this class of work is turned out. As a result, an extra three-storeyed annexe is being designed. Most of this class of work is made for contractors who supply the generating machinery, since the firm do not undertake any branch of actual erection. A considerable increase has taken place in the output of the cheaper and stronger patterns of such fittings as brackets and pendants, pointing to a great extension of the use of electric light in industrial premises, where its introduction is more an economical necessity than a domestic luxury. While the demand for smaller accessories, such as porcelain switches, holders, etc., which are a speciality with the firm, has steadily increased in London, it has been much more marked in the provinces, and more so still in the colonies and abroad. Some of the largest consignments with which Messrs. Dorman and Smith have had to deal are for erection in India, China, Japan, Russia, the Cape, and Australia, clearly showing that electric light and power are coming more prominently forward. Although there has been a steady fall in the prices obtainable, this is more due, the firm believe, to a natural increase in the facilities for production than to unhealthy competition. On the whole, Messrs. Dorman and Smith contemplate the prospects for the new year with complete satisfaction.

Doulton and Co.

In addition to their usual large business in insulators for telegraph and telephone, battery jars, and the numerous applications of pottery to electrical purposes, this company have during the year executed several important contracts for the supply of their stoneware conduit for underground electric light mains. Among these may be mentioned Edinburgh and Sunderland. The former scheme is being carried out on an extensive scale, upwards of 15 miles of conduit having been laid. The system has also been used at Chelmsford, Preston, Brighouse, Liverpool, Manchester, and by several of the London supply companies, in all upwards of 140,000 yards of "ways" having been laid. Although of comparatively recent introduction, the Doulton conduit may be regarded as one of the standard systems available to engineers. Messrs. Doulton have during 1894 supplied most of the insulators required for underground bare copper mains throughout the kingdom, and they have special facilities for expeditiously turning out large quantities of these insulators. They have also furnished the insulators for one of the important electric traction schemes in this country. Another distinct branch of this firm's business is the erection of plant for the purification and softening of water. Their process has been extensively adopted for steam-boilers, and also for manufacturing purposes where the use of impure or hard water would be attended with disadvantage. They now have in hand plant of this description for the St. Pancras electricity works.

The Electrical Company, Limited.

It is interesting to record that, notwithstanding the generally reported depression in trade, this company announce having had a very successful year. Since the promising aspect opened in November, 1893, in the incandescent lamp trade this branch has assumed unexpected proportions during the present year. The extensive stock kept and the ability of the company to supply large quantities of lamps on receipt of order have no doubt contributed to this result, and the names, the company state, of most of the largest buyers of incandescent lamps, including her Majesty's Government, may be found on their books. The high standard of quality, life, and efficiency of the lamps has been maintained throughout, and in many cases unsolicited testimonials have been received. The company's lamps are at present, as the "E. C." lamps, familiarly known throughout the country. The sale of arc lamps has almost doubled during the year, and the "Luna" type of lamp, both for direct and alternating current, has earned a high reputation. These lamps are in use in some of the largest installations both in London and the country, including her Majesty's Government, and the company state that there are few central-station circuits to which they are not already connected. A new differential alternating-current lamp with constant focus is now being brought out, and it is expected that this lamp, in connection with the well-known choking coils, will materially assist in making alternating arc lamp lighting a success, and particularly for indoor and shop lighting. It gives a very equally distributed light, the upward rays being reflected from the ceiling much in the same manner as in the case of inverted arc lamps. A new and separate automatic cut-in and cut-out arrangement has been added for high-pressure series installations. This method fulfils all requirements that may be expected from such an apparatus, which will be a valuable acquisition in all high-pressure installations. The sale of the company's well-known type of lamp-holder has steadily increased until it has reached more than three times the quantity of last year, this being due to a steadily maintained quality and to a well replenished stock. The latest patterns are stocked. In regard to the Dolivo measuring instruments, which are also well known, it is noteworthy that their proverbial accuracy, combined with a low price, have induced a ready and still increasing sale. The insulating material "stabilit" is coming more and more to the front. Some of the most prominent firms have testified to having been highly satisfied with all the qualities of this material, particularly that of high insulation, even under the most unfavourable circumstances. For high-pressure work this material is claimed to be the *sine quâ non* of all insulating materials. During the year the company have added a new department. This is for dealing with the electrical transmission of power and light on the three-phase system, of which the company's main factory, the Allgemeine Elektricitäts-Gesellschaft, of Berlin, have made a speciality for the last four or five years, with highly satisfactory results. By means of this system, distance no longer plays that important part as it does in transmission of power by direct current. By means of this system electrical energy can be transmitted from the same

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plant, both for simultaneous lighting and power purposes, motors being used which can start under full load, can easily be reversed, and having no commutators, sparking is impossible. These motors are therefore (besides being used for all ordinary purposes) particularly adapted for work in coal mines, where the ordinary motor with commutator and its inherent sparking is not advisable, and even dangerous. Although this department has only been started a short time, a number of important orders and enquiries to the extent of 8,000 h.p. are already in hand, and as a very considerable saving over any other known method of transmission of power can be obtained, the company consider it is impossible to see to what extent this branch will develop even in the near future.

Ernest Scott and Mountain, Limited.

This well-known Newcastle firm report considerable progress in all their departments during the past year. In the engineering department they have been busy with their specialities, and have supplied, or have on order, the main feed, auxiliary feed, fire, and bilge pumps for the following warships: H.M.S. "Ardent," "Boxer," "Bruiser," "Charger," "Dasher," "Hasty," "Handy," "Hart," "Hunter," "Hardy," "Haughty," "Janus," "Lightning," and "Porcupine," and also for the "Venus" and "Diana," second-class cruisers of the Talbot type. These pumps are of the duplex type specially designed to meet Admiralty requirements. The company have also in hand for the Ganges two large sets of stern-wheel machinery for two stern-wheelers being built by their agents in Calcutta. With regard to electric transmission of power, the firm have also been exceedingly busy, and have completed some important contracts of this description. These include electric pumping plant for the Lothian Coal Company, Dalkeith, N.B., capable of delivering 400 gallons of water per minute against a head of 700ft. For the Cambois Colliery of the Cowpen Coal Company, Blyth, they have completed pumping plant, replacing the old wire-rope pumping plant. This plant has been so successful that the owners estimate that the saving will not be less than £1,000 per annum. Complete electric pumping plant has also been supplied to Messrs. Strakers and Love for their Willington Colliery, co. Durham. This plant, which is worked from the waste heat from the coke ovens, costs practically nothing for fuel, and it is a new example of the economical way in which electric transmission can be utilised where fuel of this description is available Pumping plants have also been furnished by the firm to South Africa for the goldfields, and to collieries. The new type of electric coal-cutting machine introduced by the firm at the Glenclelland Colliery, near Wishaw, has also been equally successful. The cutter which is at work is daily cutting on a long wall-face 95 to 100 yards in 4½ hours 3ft. deep, and as the coal-cutter can be worked by two men it will be seen that for low seams mechanical coal-cutting of this description must replace hand labour where it is so expensive to work the thin seams. The success of this machine has been so marked that the company have in hand orders for four complete plants of coal-cutting machinery, whilst negotiations are proceeding for other plants. In the electric lighting department the company have turned out a greater number of dynamos than they have ever previously done, the machines all being of large size. In the early part of the year they completed an order for the English War Office for 13 dynamos to be combined with engines, and they have now in hand for the War Office a further order for 11 dynamos of the same type. A number of important installations has been carried out, including New Craig House, Edinburgh, this installation consisting of two boilers, four compound engines, four dynamos each capable of running 400 incandescent lamps, and about 1,400 lamps installed throughout the asylum. This is probably one of the largest and most complete installations in the world. Combined engines and dynamos have also been furnished by the firm for the Japanese cruiser "Yoshino" and for the Chilian cruiser "Blanco Encalada" the firm's improved type of central-valve engine being used for the latter vessel. The firm have carried out several important installations in private mansions, including the lighting of Dr. Tomlinson's house, Kirkby Lonsdale, and of the residence of Mr. Walter Wilson, Enfield, Gateshead. Contracts have been completed or are in hand for abroad, the most important being the lighting of the Ganges Jute Mill, consisting of two dynamos to run 800 lamps, and a rice mill in Cochin China. Two complete installations have also been supplied for mill-lighting in Russia, and Messrs. Jonas Brook and Bros.' new mill at Meltham, Huddersfield, has been fitted with a complete installation. Amongst local contracts for electric lighting may be mentioned installations for the Seaton Delaval Coal Company's New Hartley Colliery; the Garesfield Colliery of Messrs. W. Benson and Sons; the Derwent Flour Mills, Shotley Bridge; and Messrs. J. L. Thompson and Sons, Sunderland, new joiners' shop. A new departure is being made in the lighting of this shop by the adoption of arc lamps. This firm are also proposing to use the available power for working deck planers and other machinery of this description by electricity. During the year the firm have found it necessary to extend their works on account of the largely increased trade, and they have introduced electric transmission throughout. The old engines and boilers have been removed, and compound engines and boilers substituted, driving on to dynamos which feed the electric motors in the works. It is estimated that, notwithstanding that the size of the works has been nearly doubled, a saving of not less than £700 per annum will be effected. The new year opens with a larger amount of work in hand than the firm have ever had in any previous period.

Epstein Electric Accumulator Company, Limited.

This company report that their past year's business can be regarded as one of decided progress and success. After having given unexceptional results during the first years of probation, a large demand for Epstein accumulators could reasonably be expected, and these anticipations have been fully realised. Numerous batteries have been supplied for private installations, among others being for Lord Tollemache's seat at Peckforton Castle, through Messrs. Barclay and Son; and for Lord Houghton at Massingham, through the Planet Electrical Engineering Company; whilst regular orders from the Admiralty and the War Office prove that the batteries already erected give full satisfaction. Both the Cape and Natal Governments have again shipped large numbers of these cells, and most of the home railways have now Epstein accumulators in use. Many technical schools and public institutions the company state, prefer to lay down Epstein cells, as their robust constitution ensures long life, and for the same reason, in conjunction with the advantages of light weight and little space taken up, they are in large demand for electric launches, and in this direction a

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considerable amount of business has been done. The company further state that the most pronounced evidence of the high favour in which this company's productions are held is, however, to be found in the fact that in several central stations the worn-out plates of other makes are being replaced by those of the Epstein Company, whilst the new batteries required for these, as well as for the central stations of the Wolverhampton and Lancaster Corporations, are entirely of the company's manufacture. The rapidly increasing demand for the Epstein cells has necessitated much larger works, and these have been secured at Milton, Staffordshire, where the entire staff of the London works has been transferred, the offices now being at 213-217, Gresham House, Old Broad-street, E.C. As a result of manufacture on a more extended scale the prices of the cells have been revised, and the new lists of the lighting types, affording considerable advantages all round, will be issued early this month. With regard to batteries for traction purposes, the developments and improvements made by Mr. Epstein in the manufacture of secondary cells for this purpose have been of such importance, the company say, as to remove the obstacles which have hitherto acted as a hindrance to their more general and successful adoption. Durability, compactness, high capacity, and extreme lightness (the weight being reduced to one-third of the present type, capacity for capacity) are combined so effectually in the new traction cell that this difficult problem may now in reality be claimed as solved, an achievement which, while greatly widening the scope for the application of accumulators, will not fail to exert a favourable influence on traction enterprise generally, and thus be instrumental in benefiting many industries interested in this branch of work.

J. K. Fahie and Son.

This Dublin firm have been busy during the year, especially in the capacity of consulting engineers. The firm has had several important proposals under consideration as regards the utilisation of water power for electrical purposes, and seeing the extent to which this natural motive force abounds in Ireland, it is to be hoped that ere long many examples of this kind of electrical work will be brought into operation. The junior member of the firm—Mr. Angelo Fahie—has been complimented during the year by being appointed by the Lord-Lieutenant of Ireland (Lord Houghton) to the Commission of the Peace for Dublin.

E. Green and Son, Limited.

It will almost be superfluous to say anything of Green's economiser made by this Manchester firm. Its merits as a means of increasing the economy in the boiler-house are well known, and our own columns have borne testimony of the high appreciation in which it is held by its adoption in many central electric light stations. The following list, which is convincive, shows the electricity works in which it has been adopted during the past year: Salford, Stafford, Reading, Halifax, Altrincham, Wolverhampton, Dewsbury, Coventry, Bournemouth, Dover, Great Yarmouth, St. Pancras, Bedford, Tunbridge Wells, Portsmouth, Lancaster, Holloway, Nottingham, Hampstead, Kingston, and the City of London Electric Light Company, Bankside. This is a good record, but this is enormously improved when the hundreds of economisers supplied to all classes of manufacturers are taken into consideration. The company consider there is a fair prospect of business during the present year.

J. H. Heathman.

The progress of electric lighting during the year just ended has caused an increased demand for and manufacture of Mr. Heathman's extension ladders, steps, and trestles. The telescopic trestles have been in good demand, whilst the extension tower ladders have been adopted for no less than 46 installations. The latest improvement is the elevating spindles, which Mr. Heathman now fits to his ladders for supporting the side that happens to be on the lowest ground, or over a road gutter, and so setting the ladder quite perpendicular. As to the saving of expense in recarboning arc lamps, the Great Northern Railway Company's electrical engineer states that the adoption of these ladders has enabled him to dispense with five men. Thus, the saving in the labour bill soon repays the purchase of the ladders. Mr. Heathman further reports that the prospects for the current year are full of hope.

Johnson and Phillips.

It is satisfactory to note that all the departments of this firm have been uniformly busy during the past year. As an illustration of this we may mention that the construction of alternators, dynamos, transformers, and central-station accessories has been more than double that of any previous year. One of the most important of the several large contracts upon which the firm have been engaged was for South Africa, being a polyphase electric transmission of power plant which is now being erected by the firm's representative at the mines. Another important contract was the installation for the lighting of the Waterloo Goods Station at Liverpool for the London and North-Western Railway, where complete plant was supplied for 36 arc lamps and over 700 incandescent lamps. This firm also obtained the contracts for the Bedford Corporation electricity works, and the steam alternators and arc lamps for Tunbridge Wells. The number of dynamos for various purposes built during the past year has been largely in excess of that of former years, and the number of transformers has almost doubled those made last year. The cable department has been very busy with the manufacture of high-class vulcanised cables for installation and underground work, for which the number of orders still continues to increase, and a large new shop has been added to this part of the works so as to enable the work to be turned out more rapidly. Large quantities of cable have been sent abroad, principally to Spain and South Africa. An important contract executed by this department was the laying of the high-pressure feeders on the Brooks insulated oil system for the Worcester Corporation. The activity manifested in the arc lamp department testifies to the popularity of the Brockie-Pell arc lamp, for which the large number of orders received shows that it still holds its own against all competitors. Amongst others, these lamps have been furnished during the last 12 months to the General Post Offices in London, Glasgow, and Hull; to the London and North-Western Railway, Liverpool; Great Northern Railway, King's Cross and Holloway; the Lancashire and Yorkshire Railway; and the Corporations of Wolverhampton, Ealing, Londonderry, Portsmouth, Nottingham, Birmingham, and Tunbridge Wells, whilst Mr. William Whiteley, of Westbourne-grove, is also very extensively using the Brockie-Pell lamps. In addition, a large number has been supplied for lighting the Blackpool Tower and buildings, and for many other important installations. The orders for carbons have been very large during the past 12 months, and greatly in

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excess of previous years. The manufacture of the "D.P." accumulator has kept this particular department more than usually busy. Orders continue to come in steadily, showing that the advantages of the cell are being recognised as it becomes more widely known. The Perry meter, the manufacture of which has been taken up by the firm, has been greatly perfected, and this department is very active in executing orders for the latest permanent magnet type, which has proved most satisfactory in its working. On the whole, the progress made during the past year is highly satisfactory, and the firm consider that the outlook for the future is very gratifying.

Lithanode and General Electric Company, Limited.

This company, to whose admirable results in the direction of obtaining remarkable scenic effects on the stage we have occasionally referred, inform us that, owing to the success which has attended their efforts in former years in the production of novel electrical effects on the stage, they have during the past year had a great deal of work in hand. The contracts include not only work for the best theatres in London, but the company also have in hand work for several important places of amusement in the provinces. Among the towns where they are installing electrical work may be mentioned Edinburgh, Sheffield, Manchester, Birmingham, and Portsmouth. The company are inclined to think that this year they will eclipse, in point of magnitude at least, their endeavours in past years.

Meldrum Bros.

That more consideration is being given to the use of forced draught in central stations is shown by the fact that this Manchester firm have during the past year fitted their well-known furnaces at the electrical works in Bolton, Pontypool, Glasgow, Loughborough, Bootle, Blackburn, Belfast, and Dublin, whilst their adoption has been decided upon by the Town Councils of Newport (Mon.) and Stafford and by the Islington Vestry. These furnaces have been for some time past in use at the stations of the House-to-House Company, at West Brompton; the Electricity Supply Company for Spain, in Madrid; the City of London Electric Light Company; and various other stations. At Rochdale refuse disposal works the Meldrum furnace is fitted to seven boilers, house refuse being the fuel employed. The refuse is destroyed and disinfected in a novel form of combustion chamber, and the heat from the fires is utilised to raise steam in the boilers. Part of the steam thus raised is used in the production of electric light with satisfactory results, full particulars of which will probably be available shortly. Orders are already in hand for further work of this kind, and the firm state that there seems no room for doubt that their method is a distinct advance in the utilisation of town refuse as fuel for producing electric light. The convenience of this form of draught, as compared with unassisted chimney draught in central stations, the firm state, to be very great, even apart from the question of economy. The command of the steam supply is improved, as all the draught can at any moment be applied and the boilers worked to their fullest capacity during a sudden demand for steam, while the draught can be regulated with the same facility to suit a very slow fire. With respect to economy, Messrs. Meldrum Bros. say that the bars are practically indestructible, thus ensuring a saving, whilst small fuel, as well as anthracite, small coke, etc., can be burnt efficiently in the furnace.

Mosses and Mitchell.

This firm, who make a speciality of vulcanised fibre and articles made thereof, report that the past 12 months have been an all-round good year with them. Their trade in hard and flexible vulcanised fibre sheeting, tubes, and rods has been good, while their saddle staples have been in exceptionally large demand by electrical engineers.

The following is a complete list of applications for provisional orders deposited with the Board of Trade up to December 21, 1894, under the provisions of the Electric Lighting Acts, 1882 to 1890:

Title of Order and Description of Area.	Name of Promoters
Alderley Edge Electric Lighting Order. The Urban District of Alderley Edge.	The Urban District Council.
Bath Electric Lighting Order. The City of Bath.	City of Bath Electric Lighting and Engineering Company, Limited.
Bootle Corporation Electric Lighting Order. The Borough of Bootle.	The Corporation.
Brechin Electric Lighting Order. The Royal Burgh of Brechin.	Scottish House to House Electricity Company, Limited.
Carlisle Corporation Electric Lighting Order. The City and Municipal Borough of Carlisle.	The Corporation.
Leigh Urban Sanitary Authority Electric Lighting Order. The Urban Sanitary District of Leigh.	The Local Board.
Liverpool Electric Lighting Order Portions of the City of Liverpool and of the Local Government District of Toxteth Park.	Liverpool Electric Supply Company, Limited.
Llandudno Electric Lighting Order. The Urban Sanitary District of Llandudno.	The Urban District Council.
Luton Corporation Electric Lighting Order. The Borough of Luton.	The Corporation.
The County of London.	
Battersea Electric Lighting Order. The Parish of St. Mary, Battersea.	County of London and Brush Provincial Electric Lighting Company, Limited.
Newington Electric Lighting Order. The Parish of St Mary, Newington.	Ditto
Notting Hill Electric Lighting Order. A portion of the Parish of St. Mary Abbotts, Kensington.	Notting Hill Electric Lighting Company, Limited.
St. Olave's Electric Lighting Order. The District of the St. Olave's District Board of Works.	County of London and Brush Provincial Electric Lighting Company, Limited.
Strand District Electric Lighting Order. The District of the Strand District Board of Works.	Charing Cross and Strand Electricity Supply Corporation, Limited.
Margate Electric Lighting Order. The Municipal Borough of Margate.	Municipal Electric Light and Power Corporation, Limited.
Montrose Electric Lighting Order. The Royal Burgh of Montrose.	Scottish House to House Electricity Company, Limited.
Motherwell Electric Lighting Order. The Burgh of Motherwell.	The Commissioners of the Burgh.
New Windsor Corporation Electric Lighting Order. The Borough of New Windsor and the Eton Urban District.	The Corporation of New Windsor.
Pontypool Electric Lighting Order. The District of the Pontypool Local Government Board.	Pontypool Electric Light and Power Company, Limited.
Prescot, Huyton and Roby. Rainhill, Eccleston, and Whiston Electric Lighting Order. The District of the Prescot Local Board. The District of the Huyton and Roby Local Board. The Townships of Rainhill, Whiston, and Eccleston.	British Insulated Wire Company, Limited.
Radcliffe Electric Lighting Order. The Urban Sanitary District of Radcliffe.	The Urban District Council.
Salisbury Electric Lighting Order. The City of Salisbury.	Salisbury Electric Light and Supply Company, Limited.
Southampton Electric Lighting Order. The County Borough of Southampton	Southampton Electric Light and Power Company, Limited.
Stirling Electric Lighting Order. The Parliamentary Burgh of Stirling.	The Commissioners of the Burgh.

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Title of Order and Description of Area.	Name of Promoters.
Swindon New Town Electric Lighting Order. The Urban Sanitary District of Swindon New Town.	The Local Board.
Walthamstow Electric Lighting Order. The Local Government District of Walthamstow.	The Local Board.
Winchester Electric Lighting Order. The City of Winchester.	The Corporation.
Windermere and District Electric Lighting Order. The Districts of the Urban Sanitary Authorities for Grasmere, Ambleside, Bowness, Windermere, and Kendal. The District of the Kendal Union Rural Sanitary Authority. The Districts of the Urban Sanitary Authorities for Ulverston and Grange. The District of the Ulverston Union Rural Sanitary Authority. A portion of the District of the Lancaster Union Rural Sanitary Authority.	Windermere and District Electricity Supply Company, Limited.
Worthing Electric Lighting Order. The Borough and District of Worthing.	The Corporation.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BANHAM v. REDDAWAY.

SIR,—We regret to find that a serious error crept into the report which we sent you, and which we did not observe at the time.

The report says: "It appeared that several years ago the Lancashire Belt Company made a camel-hair belting for machinery, and called it Reddaway's camel-hair belting," etc. It should be: "It appeared that several years ago the Lancashire Belt Company made a camel-hair belting for machinery, and sold it as the Lancashire belting. Shortly afterwards the plaintiffs made a camel-hair belting for machinery, and called it Reddaway's camel-hair belting," etc.—Yours, etc.,

W. C. CHEW AND SONS AND HILDITCH.

10, Kennedy-street, Manchester, December 22, 1894.

[The report referred to was published on p. 758 in our last issue.—ED. *E. E.*]

THE CARBONNELLE MICROPHONE.

Telephone engineers have for a long time supposed that the microphone invented by Prof. Hughes, and a most important part of any telephone system, has but little value for long-distance working without the use of an induction coil, as first proposed by Edison: and the consequence is that practically all modern instruments used for inter urban or even urban telephone circuits are provided with induction coils, by means of which the transmission voltage is raised to a point capable of carrying a sufficient amount of current over the considerable resistance of the line circuit. The adoption of this method is of course due to the comparatively low resistance of the carbon microphone, whereby the changes of resistance set up in it, as compared with the whole resistance of line and instruments, is very small, and not enough to affect the receiver; hence the use of an induction coil or transformer at each end, and hence, also, the necessary employment of a battery for each instrument to operate the same.

M. Carbonnelle has devised a type of microphone which is based upon a very high resistance, this being normally 1,000 ohms. When the instrument is used for speaking the resistance rises to six or eight times that value, and thus represents a large proportion of the entire circuit resistance. According to *L'Industrie Electrique*, this plan effects a very great saving in more ways than one. To begin with, all the batteries are maintained at the central exchange, and none are required on the subscribers' premises. A magneto call is alone necessary for each subscriber, and the massing together of cells at the exchange enables their number to be much reduced. Thus three Leclanché cells are found to be amply sufficient for clear speech over short distances, and as in practice one set of cells is enough to work five subscribers' lines, there are only 1,800 cells necessary for an exchange of 3,000 subscribers. Usually six cells are employed in the French telephonic systems for each subscriber, or 18,000 cells for a similar exchange—10 times as many—and involving much more trouble and attention, because they are scattered all over the network instead of being concentrated at the exchange. For inter-urban speech five cells are quite sufficient to ensure clearness. For instance, the telephone system at Brussels uses an earth return. It has multiple switchboards of 200 subscribers each, but only one cell is employed per subscriber. With the high-resistance microphone, instead of induction-coil instruments, three cells each are enough for 32 communicating cords used in urban work, and five each for eight other cords kept for inter-urban service. This gives a total of 136 cells, or a saving of one-third over those required on the old plan.

A large number of advantages is claimed for the new method on the score of less waste in the cells employed, greater convenience and reliability of service, better results over long distances, and so forth: there is certainly some novelty in the device since it completely upsets ordinary ideas about successful telephone working conditions. At the same time there seems no objection to its use or introduction into systems otherwise equipped.

ELECTRICAL ENGINEERING IN NEW ZEALAND.

A large amount of work has recently been carried out by the New Zealand Engineering and Electrical Company, of Castle-street, Dunedin. Mr. R. H. Postlethwaite, one of the members of the company, writes to us that their contracts include the erection of a small central station in the town of Gore. The plant at present consists of semi-Cornish multitubular boiler, two horizontal high-pressure condensing engines connected to an independent condenser, and fitted with automatic relief valves to atmosphere. The feed water is drawn from a hot-well, and is pumped through copper coils in exhaust-pipe from engine to condenser. The engines run at 130 revolutions, the governors operating direct on the cut-off valve. The whole of this plant was built by the company. There are two shunt-wound two-pole generators of 14 units each, running at 560 revolutions. When heavy load is on, these are run in series on three-wire circuits, but as the load decreases by the use of two two-way switches one dynamo is cut out, and the other takes the load on a two-wire system, the two outside wires being in parallel, and the neutral acting as the return. The voltage is regulated in the ordinary way by altering the resistance of the shunt circuit. Pilot wires, led back from the network to Cardew voltmeters, enable a constant voltage of 112 volts to be kept on the network.

The street wiring is overhead, with bare wires arranged on oil insulators, the farthest lamp on the net being 60 chains. The net is fed by four sets of feeders of equal resistance, the longest being 35 chains. The town is lighted by two arc lamps taking 15 amperes run in series, and 32-c.p. incandescent lamps in the by-streets. These lamps are run off the network, and are controlled from the station by a magnetic switch devised by Mr. Postlethwaite. This is of great convenience, as the street lamps are only needed until midnight. To private consumers the net price is 18d. per unit, or 3s. 6d. per month per 16-c.p. lamp installed. The supply is being rapidly taken up by the inhabitants. The meters used are of the Thomson-Houston type. Besides having installed the electric light in numerous mills, both arc and incandescent lamps, the company are now erecting an over-compounded 14-unit dynamo on a private estate to take the place of a four-unit one erected by them two years ago. The owner was so satisfied with his experience of the convenience of electricity when produced by water power that he determined upon a large machine which will run day and night, and besides lighting his house will do all the cooking and heating, also providing power for the various machines upon the estate.

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ECONOMY IN STEAM RAISING.*

BY T. F. MELDRUM.

To effect the combustion of fuel for steam-raising purposes some means of producing the draught must be resorted to, and the question is whether it is better to build a high shaft and keep a column of gas in it at a high temperature, or to provide some mechanical means of either inducing or forcing the requisite air through the fire. Chimney, or "natural draught," as it is commonly called, depends upon the difference in the specific gravity due to the difference in temperature between the column of hot gases in the shaft and a corresponding column of the external air, and consequently must vary to some extent with the state of the atmosphere, humid or bright weather altering the condition considerably, whilst everyone who has had to do with the generation of steam knows how materially the direction and velocity of the wind affect the fires when natural draught is depended upon. A strong wind blowing from the ashpit, for instance, will sometimes necessitate the continual rousing of the fires to the discomfort of the stoker, as well as entailing a great waste of fuel.

Suppose instead of relying upon the chimney for draught the ashpit is closed and the required air forced in either by means of a fan or steam-jet apparatus, the same effects will be produced so far—namely, a greater pressure of air under the bars than over the fire—the difference being that instead of atmospheric pressure under the grate, and something less than that over the fire, we have approximately atmospheric pressure over the fire and something more than that under the grate. Several advantages will follow: (1) We shall be entirely independent of both wind and weather. (2) The whole heat of combustion will be available down to the temperature of the entering fluid, or even considerably lower minus the power required to produce the draught. (3) There will be no loss of draught nor cooling of gases through leaky brickwork. (4) The blast can be so regulated that no cold air whatever need be drawn through the fire-doors when they are opened for cleaning or otherwise attending to the fire, so that the heating surfaces may be kept at a more uniform temperature, greatly to the advantage of both boiler and setting. (5) The fire-grate may be considerably reduced in area and the fire therefore concentrated, by which means the large excess of air over the theoretical quantity required for combustion may be very materially reduced with a resultant much higher temperature and a consequent greater proportionate evaporation, the transference of heat being in proportion to the difference in temperature between the heating and the heated bodies. (6) As a much greater force can be readily obtained than could be the case with natural draught, except by means of an enormous and very costly edifice, greater power may be developed from a given size of boiler, or, on the other hand, much that would otherwise be considered refuse may be used as fuel with considerable advantage.

Mechanical draught may be produced in various ways—a fan may be placed in the chimney, or the exhaust-pipe may be somewhat confined at the outlet and introduced into the funnel, thus inducing a current of air through the fire, as in the case of the familiar locomotive blast-pipe. With stationary boilers, however, no such waste of the exhaust steam would be permissible, and, consequently, more economical means have been adopted. Some 20 years ago, Körting's arrangement was somewhat extensively introduced into the North-Eastern District by Messrs. R. and W. Hawthorn, of Newcastle-on-Tyne. After this the Perret furnace was extensively introduced into this country by Messrs. Bryan Donkin and Co., of London. In the furnace a water-box is placed in the ashpit, special bars with deep fins are used which dip into the water, and air is supplied by a pressure fan usually run by a small supplementary engine, as otherwise the forced draught can only be used when the main engine is running. Mr. J. Holliday, A.M.I.C.E., in a paper on the economy of steam raising, with special reference to the Perret furnace (several of which he has under his charge at the works of Messrs. Guiness, in Dublin) stated that the difference in cost of evaporating 1,000 gallons of water between the natural-draught boilers burning coal at 11s. 6d. per ton and the forced-draught boilers burning coke breeze at 5s. a ton, was 2s. per 1,000 in favour of the forced draught. But after allowing for extra labour in cleaning flues, interest on capital, depreciation, etc., as well as the very heavy items of 12s. 7d. a week for repairs to six furnaces, the net gain was put down at 9¾d. per 1,000 gallons. In a report by Prof. Kennedy and B. Donkin, jun.,† of the efficiency of a Lancashire boiler at Burnley, fitted with the Perret furnace, the heat expended in evaporating water under the special grate is put down as 4·6 per cent.; and reckoning only 3 per cent. for the power absorbed by the engine and fan, this shows a total loss of 7·6 per cent.

About seven years ago the author's firm took up the question (after having studied the subject of steam-jet blowers for a very long time previously) with a view of arriving at the best and most compact all-round arrangement for efficiency with special reference to flue boilers. After a deal of experimenting, the present form of apparatus was fixed upon, and up to the present time considerably over 2,000 furnaces have been fitted. The Meldrum furnace is an adaptation of the forced-draught closed ashpit system, the air being supplied by two steam-jet blowers to each furnace. These blowers are the outcome of long and careful experimenting, some thousands of tests having been made with blowers of all shapes, and nozzles of all kinds, and it is now confidently affirmed that the proportion of the blowers cannot be materially departed from without great loss of efficiency. Many people imagine that so long as a steam jet is inserted into a pipe the end is accomplished, but this is only true if economy of steam and pressure of air are no objects, and steam-jet blowers have been generally condemned through the wastefulness of badly designed apparatus, whereas tests made by the Admiralty and several large firms in England and on the Continent have verified the fact that under ordinary working conditions the quantity of steam used by the Meldrum blowers is only equal to about 2 per cent. of the total evaporation. The firebars employed with forced draught may be made with very narrow air spaces. Those used with the Meldrum furnace have only about 1-16th of an inch clearance so that nothing of value can fall through, and the saving in fuel from this cause alone is generally sufficient to provide all the steam required by the blowers. The bars are made interlocking, so that it is impossible to accidentally displace or lift a bar when cleaning the fire, as is often otherwise the case. The action of the steam upon the bars keeps them perfectly cool, so that clinker does not stick, and the bars last a very long time; in fact, with care, the bars will last for years, most of the bars originally fitted with the furnaces being still in use. The steam for the blowers is superheated by being passed into the furnace round the doors, and means are provided to ensure the re-evaporation of any condensed water that may enter the super-heater.

Another special feature of this furnace is the valvular dead-plate by the careful manipulation of which the primary and secondary supply of air, may be so proportioned that even, with bituminous coal, practically no smoke need be made. With the valve open a thin stream of air is admitted over the fire. An intimate admixture of air and gas takes place before they come in contact with the cool plates of the flue, and the smoke is thoroughly consumed. Having no moving parts, and positively nothing to get out of order, this system is especially applicable in a boiler-house where the greatest care is not generally available, and in actual practice it has been demonstrated that the upkeep of the apparatus costs practically nothing. The economy to be obtained depends largely upon the kind and cost of the fuel obtainable. In many large collieries, gasworks, and ironworks, the whole cost of the fuel is saved, refuse formerly carted away at considerable expense being the only fuel used. In cases where the boilers are slightly under power it has frequently been found that by applying this system the necessity of providing larger boilers has been avoided, and thus a large outlay for plant saved. When the chimney draught is insufficient through faulty construction of flues, or by the addition of extra boilers, it has frequently happened that the evaporation of the boilers has been increased as much as 25 per cent. With forced draught the heat of the waste gases may be utilised to a much fuller extent than with natural draught, and in this direction further economies may be looked for.

The Meldrum boiler has been designed with special reference to the economical utilisation of towns refuse or other very poor fuel, but may be used with advantage in burning any kind of fuel. The boiler is of the marine or return-tube type, but is provided with a door in the combustion-chamber, through which the unburnt incombustible residue of the fuel may be raked and generally for access to the furnace. The flue is made of ample diameter, and the grate placed at a considerable angle of inclination to facilitate raking the material forward. A feeding hopper is provided at the back end of the tubes, the fuel being tipped upon the platform overhead and raked into the hopper as required. The air for combustion is heated by the waste gases as they pass through the smoke-box. A tall chimney may be entirely dispensed with by substituting the exhauster, which is simply regulated so as to prevent the flame and gas blowing out of the clearing-door when the fire is receiving attention. The steam for the blower is superheated in the smoke-box. The Meldrum system of forced draught has also been somewhat largely adopted in the Midlands and South Wales in connection with puddling and heating furnaces. Similar advantages follow as with furnaces for steam raising. The bars may be placed much closer together, saving a very large percentage of fuel. Common fuel may be used very advantageously. The labour of clearing the grate is very much reduced, and also, as the maximum temperature is practically obtained, the charge may be worked off with greater rapidity, while the greater control of the air supply enables the operator to more readily adjust his flame to the required degree of activity with a consequent improvement in the quality of the finished product.

* Abstract of a paper read before the Cleveland Institute of Engineers.

† *Engineering*, August 1, 1890.

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WORK OF AN ELECTRIC CURRENT.

The first of a course of six lectures, adapted to a juvenile audience, on "The Work of an Electric Current," was given on Thursday of last week by Prof. J. A. Fleming, F.R.S., at the Royal Institution. The lecturer began by pointing out that all bodies can exist in two conditions—electrified or non-electrified—and that ability to attract or repel other bodies is a sign of the former condition. He showed how pieces of india-rubber and dry brown paper may be electrified by rubbing them with fur, and how by virtue of their electrification they can be made to attract and adhere to other substances. The use of the gold-leaf electroscope to discover whether a body is electrified or not was explained, and it was proved that the electrification of a copper sphere can spread along a metallic wire or a wet silk thread, but not along dry silk. Dufay's discovery of the two kinds of electricity was then discussed, and it was seen that the gold leaves of an electroscope with a small negative charge came together when a glass rod rubbed with silk was brought near it, but separated on the approach of a stick of sealing-wax rubbed with catskin. The next point to which attention was drawn was that these two kinds of electricity—the vitreous, or positive; and the resinous, or negative—cannot be produced one without the other, and it was shown that when a glass rod is rubbed with flannel the glass and the flannel are electrified oppositely and in equal degrees. The charges of two oppositely-electrified spheres were proved to be neutralised when the spheres are brought into contact, the discharge being accompanied by a spark. Larger sparks were obtained from a Wimshurst machine, and the movement of the two kinds of electricity along the conductors between the plates of the machine and the knobs where the discharge took place was said to constitute an electric current. Another way of electrifying bodies was then explained. The quadrant electrometer was described and employed to show that, if an insulated plate of zinc is touched with one of copper, the two plates become oppositely charged. Volta's fundamental experiment was then performed. About a century ago he immersed two plates of silver and zinc in dilute acid, and found that, when they were connected by a conductor, positive electricity flowed from the silver to the zinc, and negative electricity from the zinc to the silver, the zinc at the same time being attacked by the acid. But when there was no connection between the plates no current flowed, and there was no action on the zinc. This arrangement of Volta's, called the voltaic cell, was the first efficient means of generating electricity in any quantity. The lecturer made a voltaic cell with a silver fork, a steel knife, and an orange, and demonstrated the existence of a current by means of a Pitkin galvanometer whose construction he had previously explained. He showed that no appreciable current can be obtained by using gold, silver, and an orange, the reason being that neither gold nor silver is acted on by weak acid, whereas for the construction of a voltaic cell it is necessary to select two metals, one of which is much more readily attacked than the other by the liquid in which they are immersed.

The second of the lectures was delivered on Saturday afternoon, when Prof. Fleming began by bringing forward some theoretical considerations as to the nature of what the old electricians termed a charge of electricity. He proved experimentally that the charge appeared to reside on the outside surface of an electrified cylinder, and that no signs of electrification could be found on the inside surface. By using a Leyden jar so constructed that its constituent pieces could be taken apart, he showed that the charge was apparently neither on the outside covering nor in the inside lining, but in the glass which formed the non-conducting medium between the two. He employed an analogy in explanation of the action of the jar. He supposed a piece of pipe to be rigidly closed at the ends and divided by indiarubber diaphragms into a number of separate compartments. A smaller tube, which could be closed by a stopcock, and which was fitted with a movable plug in its bore, was supposed to join the two extreme compartments, and the whole apparatus was considered to be full of water. If, now, the plug were moved a short distance a certain amount of water would be displaced, though it would not be able to move freely, and, if the stopcock were then shut, the indiarubber diaphragms would be kept in a condition of strain which would be relieved when the tap was opened. In like manner a charged Leyden jar might be considered as being in a condition of internal strain, which was relieved on discharge taking place. Prof. Fleming gave as a definition of E.M.F. any cause which displaced, or tended to displace, electricity in a body. He proceeded to further consideration of the methods by which the electric current might be produced. He showed a photo-electric cell consisting of two cylinders of tinfoil, separated by blotting-paper and immersed in plain water contained in a glass vessel. When this cell was exposed to the influence of light rich in chemical rays, such as was given by burning magnesium, the galvanometer gave evidence of the existence of a current. Several forms of thermo-electric couples were then exhibited and explained, and the use of a thermo-electric junction for measuring temperature was mentioned. Prof. Fleming next dealt with the production of a current by means of magnets, and went over some of the elementary facts of magnetism. He showed that a conductor conveying a current behaved exactly like a magnet, and could magnetise a piece of iron or steel placed within its influence, and he demonstrated the property possessed by a magnet of inducing a current in a surrounding coil of wire. Lastly, he dealt with the production of a current by the physiological action of certain living creatures, such as the torpedo and the gymnotus, or electric eel. A specimen of the latter was exhibited in a tank, and its electric powers proved by means of a galvanometer. Positive electricity was said to be given off from places near its head and negative from places near its tail. It was therefore able, by bending itself into the form of an incomplete circle, to send a shock through a small fish and perform what was now called an act of "electrocution." Faraday's acute speculations as to the mode in which the eel acted were mentioned, and it was suggested as probable that it possessed organs which resembled a secondary rather than a primary battery, and which enabled it to transform some of its energy into the form of electricity and store it up.

In his third lecture, delivered on Tuesday, Prof. Fleming began by discussing the chemical action of the current. Some liquids, he said, can be decomposed into their constituents by means of an electric current; such liquids are called electrolytes, and the products of the electrolysis ions, these terms having been coined by Whewell at Faraday's request. The lecturer then showed the electrolysis of a solution of sugar of lead into metallic lead and acetic acid, and pointed out that the deposition of lead upon the electrode became irregular if the process were hurried too much. This simple experiment he declared to involve the whole art of electro-plating, which he further illustrated by employing electricity to deposit copper on a carbon rod from a solution of sulphate of copper. He then proceeded to discuss the theory of electrolytic action, taking, as an example, the decomposition of chloride of silver. He supposed that one electrode was positively charged, and the other negatively; that each molecule of salt was not continuously composed of the same two atoms of silver and chlorine; and that each atom liberated from union with another carried with it a charge of electricity. He then employed a happy analogy drawn from a ball-room, possessing on one side a peculiar attraction for the ladies and on the other for the gentlemen. No pair of partners were to dance together for more than a few turns, but were to separate and either find new partners or yield to the attractions of one of the sides. The room would thus at any moment be full of pairs dancing and of individuals gradually making their way to one side or the other according to their sex. In the same way the vessel in which electrolysis was going on might be viewed as full of molecules of chloride of silver, and of disconnected atoms of chlorine and silver passing to one electrode or the other according to their polarity. The lecturer then stated the law that a given quantity of electricity was always able to liberate the same amount of ions from a particular solution, and, after explaining how an ampere may be defined from this fact, went on to give an experimental proof of its truth by showing that, if a certain tube could be filled with oxygen from the decomposition of water by a certain current in 20 seconds, it could be filled in 10 seconds if twice the current was employed. He then described the curious change which was undergone by two platinum plates used as electrodes, in the decomposition of water, for example. They were no longer the same electrically, but could give off a current as if they were made of zinc and copper respectively. The reason was that one was impregnated with hydrogen and the other with oxygen, and thus their electrical behaviour was altered. The secondary battery had been developed from this fact. Planté was the first to follow it up, and he found the best results could be obtained from lead plates. When these were used as electrodes in acidulated water, oxide of lead was formed on one and spongy lead on the other by the action of the current, and Faure, in 1880 or earlier, noticing this fact, conceived the idea of employing ready-made lead oxide on his plates, instead of making it by the current. Secondary batteries were now made both on Faure's and Planté's principles, since each had its advantages. Prof. Fleming then passed on to consider the heating effects of the current. He showed that a conductor through which electricity was travelling became heated, but to different degrees, according as the material of which it was composed was of a higher or lower electrical resistance. Thus a current passing through a chain made up of alternated links of iron and copper rendered the iron red hot, but left the copper unaffected to the eye. The heating effects of the current were also illustrated by passing it through a platinum spiral immersed in a little water, which soon began to boil, and its practical applications exhibited in the form of electric ovens, kettles, flat-irons, cigar-lighters, etc. It was proved experimentally that a conductor, when heated by the passage of a current, became elongated; and a Cardew voltmeter was shown, the action of which depended on this fact.—*The Times.*

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MEMORANDUM ON LIGHT RAILWAYS IN BELGIUM.

The Board of Trade recently instructed Major G. W. Addison, R.E., to visit Belgium and investigate the construction and working of light railways in that country. Since then Major Addison has prepared the following report:

Light railways in Belgium are entirely in the hands of the Société Nationale des Chemins de Fers Vicinaux, formed by an Act of June 24, 1885, with the object of establishing light railways along the roads. Although the Government retains the power of granting concessions to private companies for similar undertakings, the Société Nationale has always the first offer. The capital of the Société Nationale is contributed one-fourth by the State and three-fourths by the provinces and communes directly interested in the construction of a line; private individuals may also subscribe, if they wish to push on a line, to the extent of one-third the capital required. As will be seen further on, the actual amount subscribed privately is very small indeed. The contributions of the provinces and communes are raised, with the assistance of the State, by means of 90 years' annuities at 3½ per cent. interest, which interest includes the sinking fund for the redemption of the debt in 90 years. If the annual profit on any line, after deducting working expenses, is insufficient to pay a dividend of 3½ per cent., the balance must be made good by the province and communes concerned. When more than 3½ per cent. is paid certain portions of the balance are allotted to the formation of (*a*) *fonds de prévision* for future improvements to the line, and (*b*) a reserve fund applicable to the system generally, and not only to the particular line earning the profit, as in the case of the *fonds de prévision*. In 1893 about 25 per cent. of the lines earned dividends of 3½ per cent. or more. Should a line fail to earn sufficient to pay working expenses, the loss to that extent falls upon the Société Nationale, but the latter is not responsible for the interest, etc., of the annuities.

The headquarters of the society are in Brussels, and it is administered by a Board consisting of a president, four members, and a general manager; the president, two of the members of the Board, and the general manager being nominated by the King, all the society's operations are, practically speaking, controlled by Government. There is also a "Comité de Surveillance" of six members, appointed by the annual general meeting, at which each province and commune is represented by one delegate, and private subscribers have a certain number of votes. The demand for a new line must come from the council of the commune to the National Society, giving full information as to the population and industries to be served by the proposed line, and the route the line should take. The commune must undertake to repay to the society any expenses incurred in making surveys, etc., should the line not be constructed, and they must furnish details of their financial position and ability to subscribe their share of the required capital. The society, after making estimates of the cost of constructing and working the line, and arranging with the provinces and communes concerned the share which each should contribute towards the capital, forwards a report, with all plans and documents, to the Minister of Agriculture and Public Works; the latter decides whether any public enquiry is necessary or not before the concession is signed by the King. The lines are made by contract under the supervision of the society. It is calculated that 2,000f. per kilometre (£128 per mile) should suffice to repay to the society preliminary expenses and the cost of watching the work of construction.* When finished, the lines are handed over to subsidiary companies to maintain the permanent way, keep up the rolling-stock, and work the lines generally. These companies receive a fixed percentage of the gross receipts, with, generally, but not always, a guaranteed minimum of 2,000f. per kilometres (£128 a mile) a year. A separate account, both as regards construction and working, is kept by the Société Nationale for each line, and they furnish an annual report giving very full details of everything. From the report of 1893 I find that:

(1) The society was then working 58 lines, with a total mileage of about 730 miles; four lines, 40 miles in length, were in course of construction; and projects were under consideration involving about 900 miles additional.

(2) The gauges of the above 62 lines were: about 615 miles, 1 metre gauge; about 125 miles, 1·067m. gauge; about 30 miles, 4ft. 8½in. gauge. The intermediate gauge lines (1·067m.—*i.e.*, about 3ft. 6in.) form extensions of the Netherlands "Vicinaux" railways. Practically, therefore, the Belgian lines may be considered a metre gauge system.

(3) The subscribed capital amounted to about £2,350,000, subscribed in the following proportions—viz., by the State, 27 per cent.; by the provinces, 28 per cent.; by the communes, 41 per cent.; by private individuals, 4 per cent.

(4) The cost of constructing the lines, providing rolling-stock, etc., averaged £2,688 per mile—the sum paid for land being less than £220 per mile of line.

(5) The system included sidings at 62 stations of the main railway lines, and 93 sidings constructed for private companies and individuals. Of the latter about one-third are in the interest of agriculture.

(6) The society had 245 locomotives, 663 passenger carriages, 1,574 wagons and luggage vans. The locomotives are principally of 18 tons weight, but there are a few lighter, and some up to nearly 30 tons in weight. Of the wagons, more than 70 per cent. carry 10 tons, the remainder being for freights of five tons (a few also for 20 tons).

(7) The working expenses were 71·31 per cent. of the gross receipts, the expenses including 175f. per kilometre (about £11 per mile) to the society for administration, etc.

(8) The receipts from passengers and goods respectively were 72 per cent. and 28 per cent. of the total.

(9) The mean recent dividends paid on all the lines are: 1890, 2·65 per cent.; 1891, 2·75 per cent.; 1892, 2·76 per cent.; 1893, 2·80 per cent. In 1893 four lines were unable to pay working expenses, and there appears to be a loss to the society on the working of those lines to the end of 1893 of rather over £3,000. On the other hand, the society had a reserve fund of between £8,000 and £9,000, and the *fonds de prévision* amounted to nearly £5,000.

(10) During 1893 no accident is said to have occurred to any person due to collisions or to the train leaving the rails. The actual number killed and injured were: passengers killed 5, injured 3; companies' servants killed 0, injured 3; other persons killed 20, injured 7. In nearly every case of death contributory negligence is claimed to relieve the company working the line from blame.

I thought it desirable to inspect a line intended primarily to serve an agricultural district, and with this object the line from Andenne to Eghezée was selected. M. de Burlet, the general manager of the Société Nationale, kindly sent one of his engineers, M. Paul Berger, with me. This line is about 12½ miles in length, and is mainly dependent upon its goods traffic, which produced last year about 60 per cent. of the gross receipts of the line. Like all the Vicinaux railways, it is constructed on the road, excepting where steep gradients, etc., make slight diversions desirable. Usually a line of way is formed at one side of the road, raised slightly by ballast etc., and separated from the remainder of the road by kerbstones; it resembles a footpath alongside a country road. In this way the railway is not available for ordinary carriage traffic, nor is it used by pedestrians. Through villages, and where roads have to be crossed, the line is of the usual tramway type.

The line is of one metre gauge, with steel rails weighing 21½ kilos (42lb.) per yard. In the towns, I believe, they use a deeper rail, weighing about 60lb. per yard. The rails are of the "Vignolles" type, secured by dog spikes to creosoted sleepers about 4ft. 8in. by 8in. by 4in. Points are worked in the country by a lever, at the side of the line, and in towns by a key, fitting a screw-head placed between the rails. I did not obtain details of the curves and gradients of the Andenne-Eghezée line, but, as examples of the Vicinaux system, I take three lines, amounting to 45 miles in length, where the sharpest curves are 30 metres, 35 metres, and 40 metres respectively—*i.e.*, about one and a half to two chains radius. On the same lines there are gradients of 1 in 20 and 1 in 25. Round the very sharp curves gauge ties are used to prevent the rails from opening out. Guard rails are only used in towns. The speed is limited, by regulation, to 30 kilometres (about 18 miles) in the country and six miles per hour in towns and through villages; the time allowed in the time table for the journey from Andenne to Eghezée, 12¼ miles, averages one hour 25 minutes, but one train in the day each way only takes about one hour five minutes. On another line, Ostende-Furnes, which is chiefly a passenger line, the trains take about 1¾ hours on a journey of 20 miles.

The engine of the Andenne line, 18 tons weight, had six wheels coupled, each of 3ft. diameter; all moving parts were cased, and it was driven from either end (the driver, of course, always being in front). It was, in fact, an ordinary tramway locomotive. The engine was only provided with a hand screw brake. I notice in the police regulations, issued from the office of the Minister of Agriculture, etc., that the brakes on the engine wheels should be sufficient alone to stop a train on the steepest gradients in a length of 30 metres (33 yards). They were trying a simple form of continuous brake actuated by either the driver or guard releasing a cord; upon which weights fell and applied the brakes; the cord passed over the tops of the carriages or wagons (to which this arrangement is equally applicable). The engine always carries two men—a driver and a stoker.

The train in which I travelled was composed, at starting, of one goods wagon next to the engine, one passenger carriage, and one *fourgon* or luggage van; subsequently we dropped the goods wagon, but picked up three more wagons. The mixed trains usually have one van in front of the train in one direction and in rear on the return journey. The van carries any

* This amount is included in all estimates.

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passenger luggage and goods of small bulk; when not employed elsewhere, the guard rides in the van and makes out his way-bills, etc. With the suburban passenger trains there is usually no van, but the society has a certain number of vehicles forming a second-class compartment and a small van. Vans have a post office letter-box in which letters can be posted at the various halting places. The wagons, carrying 10 tons of goods, weighed about four to five tons, and had four wheels coupled. They were of various patterns, according to the purposes for which they were intended to be used. The carriages on the Andenne-Eghezée line are about 20ft. in length to the ends of the buffers, and about 8ft. 3in. in width; they are divided so that one-third forms a first-class and the remainder a second-class compartment, with seats across the carriage, a central passage, and doors at the ends opening from platforms. They are provided with a screw hand-brake on one platform. There are various patterns of carriages in use on other lines. On one line running into Brussels I noticed a carriage nearly 40ft. long, with bogies at each end; I also saw some carriages with a very small wheel base, short bodies over the wheels, and large outside platforms. In all, however, the seats were placed across the carriages, and not along the sides. If more than two passenger carriages go with the train, they are supposed to have a second guard or brakesman. The length of the train is fixed for each line according to the gradients, the brakes in use, etc., but as a general rule it is limited to about 130ft. (engine, van, and five carriages or wagons as a maximum).

There were several sidings on the Andenne-Eghezée line, at the side of the road, so that carts could draw up alongside the goods wagons either to load or unload them. The running line is then outside the siding, on land acquired for the purpose. Sidings on the level usually had two dead-ends, roughly made with a bank of earth and a few timbers. The stoker acts as foreman shunter at the sidings. The train only picks up loaded wagons, and does not stop to load *en route*. There were no signals of any description in use on the line I examined. M. de Burlet informed me they were only used at specially dangerous points, such as level crossings over main lines of railway, where there are safety points, and a signal indicates to the driver when he is approaching these points. Before sunrise, after sunset, and during foggy weather the locomotive carries two white lights in front, one on either side, and a green light is attached to the tail of the train. A room in an inn generally forms a waiting-room for passengers, and a place where parcels can be left either until called for or to be picked up by the train. No tickets are, however, issued, or other ordinary station business transacted. I believe it is not usual to make any payment to the proprietor of the inn, who gladly affords these slight facilities in return for the custom brought to the house. In addition to the stations as above, there are also fixed points (with a notice board only) where the train stops if there is anyone to pick up or set down, such as at important cross roads, etc.

At Eghezée, the Vicinal railway connects with the main railway system; there is, however, neither here nor elsewhere, any physical junction of the metre gauge with the 4ft. 8½in. gauge line. Passengers alight in the road, near to the main-line station, and there is a goods siding alongside a similar siding of the main line—that is all. Only the Vicinaux trains of 4ft. 8½in. gauge run into the stations of the main lines. The only other point I have to mention in connection with the working of the Chemins de Fer Vicinaux, is that the police regulations issued by the Minister of Agriculture, etc., fully recognise the necessity for protecting the railway as well as the public. Riders, drivers of carriages, carts, etc., are warned upon the approach of a train to keep at least 5ft. clear of the rails; if the rider or driver is not sure of his horse, he is enjoined to lead it until the train has passed. Before crossing the railway, persons are instructed to ascertain that no train is near. The level crossings of roads, excepting in a few instances, are not watched or guarded in any way.

INTERDEPENDENCE OF PATENTS.

Two cases have just come before the courts on this subject—Semet and Solway's prolongation petition, before the Privy Council on December 8, and the case of Muirhead *v.* The Commercial Cable Company, on December 18. In the former, the question discussed was the effect of European patents on a British patent; while in the Muirhead case the point was the effect of a British patent on a United States American patent. The patent laws of most countries provide for the cesser of the domestic patent on the lapse of a prior foreign patent for the same invention. This was also the rule in England prior to January 1, 1884; and in considering British patents it is necessary to consider those granted before that date separately from those granted since, for the Patent Act, 1883, repeals the 1852 Act, and Section 25 of the 1852 Act (which dealt with this point) is not reproduced. Consequently, the lapse of foreign patents has no effect on British patents granted since the Patent Act, 1883, came into force. With regard, however, to patents granted before January 1, 1884, the law is not quite so clear, as Section 113 of the Patent Act, 1883, declares that the repeal is not to "affect the past operation of any of those enactments or any patent granted . . . or liability acquired. . . ."

This point has been the subject of discussion in a somewhat recent case. In the year 1891 the owners of Jablochkoff's patent for dividing electric light applied for a prolongation. The Privy Council could not see their way to advise a prolongation of this patent, chiefly on the ground that the patent was invalid; and although the Judicial Committee did not express a decided opinion on the question, it was evident they considered that the expiry of prior foreign patents was a very serious obstacle in the way of a prolongation.

Semet and Solway's prolongation case can be differentiated from Jablochkoff's. In Jablochkoff's case the expired patents were prior to the English patent, and consequently within the express words of Section 25, and, moreover, had expired before January 1, 1884. In Semet and Solway's patent the foreign patents were all dated after the English patent, and the utmost that could be urged against the prolongation was that this case was within the spirit of Section 25. The Lords of the Privy Council held, however, that Section 25 of the Patent Act, 1852, did not apply, and that they had power to recommend a prolongation. Having satisfied themselves on the merits of the invention, their lordships advised a prolongation of five years.

Muirhead's action against the Commercial Cable Company was one of extreme interest, as it related to Muirhead's system of duplex telegraphy, whereby two messages can be despatched in contrary directions along the same wire. So far as the law point is concerned the case is comparatively simple. Muirhead took out an English patent in 1876 for duplex telegraphy, and in 1880 took out a United States patent also for duplex telegraphy. The 14 years of the English patent ran out in 1890; whilst the American patent would run for the full 17 years—namely, to 1897—unless cut short by reason of the expiry of the English patent. By the United States law the United States patent would expire with the British patent, supposing it covers the same invention. The simple point, therefore, came to this—was the United States patent of 1880 the same as the British patent of 1876? The judge of first instance held that the two were different, and now the Appeal Court held (Lord Esher dissenting) that the two inventions were substantially the same. The result of the litigation is that there is a balance of judicial decision in favour of each litigant. Although the action is nominally for £3,500, the amount in dispute is about ten times that sum. If the United States patent is in force the Commercial Cable Company, who are licensees, will have to pay royalties until the end of the 17 years. The case will accordingly be the subject of appeal to the House of Lords. A case which brings into discussion United States law is of interest, and although the United States law is regulated by their revised statutes, it is possible to see that the underlying principles are common to both countries. Those persons, however, who have to deal with patent procedure in Washington know that there is often a great apparent difference between British and United States specifications for the same invention. This is the case particularly with the claims, and consequently too much reliance cannot be placed on apparent differences between the United States and British specifications. The decision of the majority of the Court of Appeal will be found to be correct.—*G. B. E. in the "Law Journal."*

COMPANIES' MEETINGS.

ELMORE'S FOREIGN AND COLONIAL PATENT COPPER DEPOSITING COMPANY, LIMITED.

The fifth annual ordinary meeting of this Company was held at Cannon-street Hotel on Monday, Mr. F. L. Rawson in the chair.

The Chairman moved the adoption of the report and accounts. He pointed out that the general expense of carrying on the business of the Company was almost one-third less than before The Board had decided to write off the value of the deferred shares in Elmore's American and Canadian Patent Copper Depositing Company on the ground that there was no hope of such shares ever realising anything like their face value. This, however, did not represent any actual pecuniary loss, as the Company would continue to hold the shares for whatever they might ultimately realise. After providing for this reduction in the Company's assets, there remained a surplus of £166,417 5s 5d. The past year had been a most trying one, but the Board believed that their difficulties, which were chiefly of a financial character, had now been overcome. The French company had escaped liquidation, and the German company had attained to a perfectly satisfactory position from a manufacturing point of view. The result of the present working of the companies here and on the

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Continent confirmed the directors' belief that the statements made by the Company would be more than borne out. Negotiations were on foot for the sale of the Belgian, Indian, Italian, Russian, and Spanish patents. In order to raise the necessary capital to carry on the Company it was proposed to issue £5,000 of first mortgage debentures.

Mr. J. J. Atkinson seconded the motion, which was agreed to.

The question of raising fresh capital was then discussed. It appeared from the chairman's statement that the directors had met the most pressing financial claims against the Company during the year.

On the motion of the **Chairman**, Mr. Shurmur (the secretary) was elected as director in the place of Mr. W. Elmore, who retired.

ELMORE'S AMERICAN AND CANADIAN COPPER DEPOSITING COMPANY, LIMITED

The annual meeting of this Company was held on Monday last, Mr. J. J. Atkinson in the chair.

The **Chairman** said the directors would have been very glad had they been in a position to announce the sale of the property during the past year, but there had been no offer for it at anything like a satisfactory figure, and there was no likelihood of a sale until they were in a position to show beyond all question the commercial value of the patents. The Company's friends in America were absolutely satisfied in regard to the merits of the process on every point except that of the cost of production, although upon this point the directors could furnish expert testimony of the highest authority. However, until the European companies could show a substantial profit for the working of the patents their Company was not in a position to insist upon a proper purchase price for their rights.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Saint-Die (Vosges, France).—The Municipality invite tenders by February 1 for the concession for a central electric light station for the town.

Louvain (Belgium)—Tenders are invited by February 1 by the local authorities at the Hotel de Ville for a concession for an electric tramway from the railway station to the Grand Place, Louvain.

Hanley.—The Corporation of Hanley are prepared to receive tenders for the supply and erection of plant, etc., at the central electric light station. Tenders are to be delivered by January 5. Particulars appeared in our issue of last week.

Bristol.—Tenders are invited for the installation of the electric light at the Guildhall and a portion of the Council House, for the Corporation. Plans may be seen at the office of the city electrical engineer, Mr. H. Faraday Proctor, A.M.I C.E., M I.E.E , Temple-back, from whom specifications may be obtained. Tenders to be sent to the chairman of the Finance Committee, the Council House, Bristol, by January 18, endorsed "Tender for Electric Light Installation."

Stockport—Tenders are invited for providing and fixing complete a fuel economiser, for the Corporation. Plans of the boiler-house, now in course of construction, together with the specification of the work required, can be seen and form of tender obtained at the office of Mr. A M. Fowler, 1, St. Peter's square, Manchester. Tenders to be delivered at the office of Mr Walter Hyde, town clerk, 2 Lord-street, Stockport by January 16, endorsed "Tender for Economiser." The standard rate of wages in the district will have to be paid by the contractor in the construction of the work.

Birmingham.—The committee of the Birmingham Municipal Technical School invite tenders for the installation of the generating plant, fittings and appliances for both the electric lighting and transmission of power by electricity in the new school. Plans of the building may be seen, and specifications and forms of tender obtained, at the offices of Messrs. Hy. Lea and Thornbury, consulting engineers, 38, Bennett's-hill, Birmingham, on a deposit being made with them of £2 2s., which will be returned on receipt of a *bond fide* tender. The committee do not bind themselves to accept the lowest or any tender, and no tender will be considered except upon the prescribed form and accompanied by an undertaking that not less than the minimum standard rate of wages current in the district is paid by the contractor and sub-contractors (if any). All tenders must be sent in to Mr. Geo. Mellor, secretary, endorsed "Tender for Lighting," on or before January 12.

RESULTS OF TENDERS.

Taunton.—The Fowler-Waring Cables Company have obtained the contract, at £681, for the supply to the Town Council for the necessary cables, etc., for making the house connections in connection with No. 2 sub-station.

Belfast—The contract for the electric lighting of the Belfast Exhibition, to be opened in the Linen Hall grounds early in April, has been placed in the hands of Messrs. William Coates and Son, of Fountain-street, Belfast, to be carried out under the superintendence of their electrical engineer, Mr. E. S. Dashwood. The plant, which will consist of steam and gas engines, will be capable of supplying 100 2,000-c p. arc lamps and 1,000 16-c p. incandescent lamps with reserve. This firm is also engaged on several small contracts in the city and neighbourhood.

BUSINESS NOTES.

Hull.—The number of customers for the electric light is 268 as against 134 a year ago.

Killarney.—The question of the electric lighting of Killarney District Lunatic Asylum is being considered.

Aberdeen.—The new police offices will probably be occupied by the end of the summer. They will be lighted electrically throughout.

High Wycombe.—Mr. Hammond has presented a report to the Town Council as to the proposed introduction of the electric light.

Hove.—The Town Council have instructed their surveyor to report on the advisability of lighting Church-road and other thoroughfares by electricity.

Dundee.—A proposal has been made to light the tramcars and omnibuses by electricity, the same method being adopted as on the Glasgow Corporation cars.

Edinburgh.—A Christmas carnival is being held in the Waverley Market, and a brilliant electric illumination has been carried out by Messrs. King and Co., Leith.

West India and Panama Telegraph Company.—For the half-month ended December 31 the receipts show a decrease of £542 as compared with the corresponding period of 1893

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 30th ult. amounted to £837, as compared with £619 in the corresponding week of the previous year.

Luton.—The Town Council have been informed by the clerk that he has received from the parliamentary agents prints of the draft provisional order for the supply of electricity for the borough of Luton.

Exhibition at Salisbury.—Mr. E. R. Dale, A I.E.E., of Sherborne, Dorset, asks those firms who wish to be represented at the forthcoming Electrical Inventions Exhibition at Salisbury to send particulars to him.

Devonport.—The Town Council have received a letter from the solicitors of the Brush Electric Light Company stating they do not intend to proceed with the application for a provisional order to light Devonport by electricity.

Worcester.—There have been 36 candidates for the position of electrical engineer to the borough. The subject is still in abeyance, owing to differences of opinion between the Electricity Committee and other members of the Council.

Direct Spanish Telegraph Company, Limited.—This Company has opened offices at Liverpool and Manchester for the reception and delivery of telegrams exchanged with Spain by their direct cable system between England and Spain, *vid* Falmouth-Bilbao.

Andrews's Foreign Syndicate, Limited.—This Company has been registered, with a capital of £4,000, to acquire and deal with the patented invention of J. D. F. Andrews and J. C. B Andrews for improvements in electric conductors and joints therefor for electric lighting.

Partnership.—Mr. Henry Edmunds, 39, Victoria-street, Westminster, and Salford Manchester, has brought into partnership Mr. Godfrey Blundell Samuelson, the son of Sir Bernhard Samuelson, Bart , M.P. The style of the firm will remain W. T. Glover and Co., as heretofore.

Hobart Electric Tramway.—The Hobart Electric Tramway Company. Limited, gave notice last week that interest on coupon No. 6 of first and second mortgage debentures would be payable at the Commercial Bank of Scotland, Limited, 62, Lombard-street, London, E.C , on and after 1st inst.

Appointments.—Mr A. G. Roe of Bournemouth, and Mr. G. H Swetenham, of Ealing, have been appointed electricians to the P. and O steamers "Kaiser-i-Hind" and "Shannon" respectively. They qualified under Mr. Ronald A. Scott, M I.E.E., Acton Hill Electrical Engineering Works, Limited.

Coventry. The Town Council have received tenders for electric meters from the Westinghouse Electric Company, Electric Construction Company, Limited, British Thomson-Houston, Limited, General Electric Company, Messrs. Chamberlain and Hookham, and Mr. C. A. Muller. The tenders are under consideration.

City and South London Railway.—The receipts of the Company for the week ended December 30 were £859, against £837 for the corresponding week of 1893, or an increase of £22. The total receipts for the past half-year amount to £23,306, as against £21,886 in the corresponding period of 1893, an increase of £1,420.

Kensington.—There has been issued the Kensington Vestry report for the financial year March 26, 1893, to March 25, 1894, in which reference is made to the revocation of the order of the House-to-House Electric Light Supply Company, Limited, as regards a portion of the area. This took place on December 1, 1893.

Payment of Coupons.—The Salt Lake and Ogden Gas and Electric Light Company gave notice last week that the coupons of the company, due on the 1st inst., would be paid at the National Provincial Bank of England, Bishopsgate-street, London, E.C., or at the Farmers' Loan and Trust Company, New York, on and after that date

Western and Brazilian Telegraph Company.—This Company has received from its representative in Rio de Janeiro the following telegram, dated December 26: "Budget Bill containing purchase clauses signed by President of Republic on Christmas Day." For the week ended December 22 the receipts were £3,141, and for the past week £2,829.

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Sunderland.—The Town Council are going to appoint an assistant to Mr. Vesey Brown at a salary of £120, owing to the increased duties which will have to be undertaken by the electrical department when the supply of current is commenced. The public library is to be lighted electrically. Applications have now been received for 1,173 lights.

Silveroid Company, Limited.—This Company has been registered with a capital of £400 to carry into effect an agreement for the working of a secret process for the electrical deposition of silver upon metals usually electrotyped, made between C. H. Woolf and A. E Hayman of the one part, and S. F. St. Germain, S. Bertram, B Van Praag, A. Sims, H. G. Campion, and H. S. Simmons of the other part.

Electric and Inventions Exhibition.—An electric and inventions exhibition is to be held in Salisbury. It is expected that the exhibition will be opened about the end of this month. Intending exhibitors are requested to send full particulars for catalogue to the promoter and general secretary, Mr. E. R. Dale, Sherborne, Dorset, and care of Mr. J. Parsons, 100 Bedwin-street, Salisbu y.

City.—The new buildings of the Commercial Union Assurance Company are to be lighted throughout by means of electricity The directors have appointed Messrs. Handcock and Dykes, Victoria-street, as the consulting engineers to supervise the work throughout. and Messrs. Hayward Tyler and Co., Whitecross-street, have the contract for the installation. The number of lights will probably be about 600.

New Firm.—Mr. Arthur H. M. Francis, formerly branch manager in Dublin for Woodhouse and Rawson United, Limited, and late representative of the Edison and Swan United Electric Light Company, Limited, for the East, South and West of England, has formed the new firm of Francis and Spilsbury, electrical engineers and general electrical agents, Mansion House-chambers, 20, Bucklersbury, Queen Victoria-street, E.C.

Gilbert Gilkes and Co., Limited.—This Company has been registered with a capital of £20,000 to acquire the business of a civil and mechanical engineer carried on by Gilbert Gilkes, as Gilbert Gilkes and Co., at the Canal Ironworks, Kendal, Westmoreland, and to carry on the business of ironmasters. steelmakers, iron and steel manufacturers, mechanical and electrical engineers, toolmakers, brassfounders, tinplate-workers, metalworkers, boilermakers, millwrights, etc.

Chelmsford.—The Chelmsford Electric Lighting Company, in reply to the petition of consumers asking that the electric supply should be continued for as many hours as possible during the dark days, state that they will endeavour to meet the request as far as lies in their power. It is absolutely necessary, however, to turn off the current for at least one hour a day for testing purposes, and for a longer period than this for a few days for the purpose of connecting new customers to the system. The fixed hours during which the current will be switched off every day will be from 12 to 1.

Universal Electrical Fittings Company, Limited.—This Company has been registered with a capital of £6,000 to carry on the business of metallurgists, metalfounders, metalworkers, woodworkers, toolmakers, electrical instrument makers, electrical contractors, manufacturers of and dealers in or affixers of dynamos, lamps, meters, transformers, conductors, switches, lampholders, brackets, electroliers, and all or any kind of electric materials, apparatus, appliances, articles, and things in connection with electric lighting, electric traction, telegraphs, telephones, or any other branch of electrical work.

Edmonton —The local authority has received the following tenders for telephonic communication and electric call fittings and for maintenance: F. E. Stewart, £122. 2s, ordinary maintenance £17, special £22; Vaughton and Co, £193, maintenance £28; Private Wire and Telephonic Institution, £268, maintenance £20; J. Faulkner, £245, maintenance £35; J. E Cullum, £139, maintenance £13; Blenheim and Co, £277 5s, maintenance £16 10s; Consolidated Telephonic Construction and Maintenance Company, £307, maintenance £9; National Telephone Company, £175, maintenance £24; J. Sax and Co, £244 10s. These tenders have been referred to the engineer.

Light and Heat Exhibition, 1895 Incorporated.—This Company has been registered as a guarantee company. For the purposes of registration the Company is declared to consist of 100 members, each liable for the sum of £1 in the event of winding up. Object: to adopt and carry into effect an agreement, made October 4, 1894, between the Kensington Woodhouse Park Syndicate, Limited, of the one part, and J. Furley, J.P., of the other part, for the acquisition of the premises, etc., known as Woodhouse Park, Shepherd's Bush, and to carry on in London during the year 1895 an exhibition of manufactures, inventions, and objects of interest connected with actual means of lighting in all its branches.

Appointments Vacant.—The British Guiana Postal Telegraph Department want an assistant electrician. Applicants must have a thorough knowledge of the construction of telegraph and telephone lines. be conversant with the adjustment and working of telegraph and telephone apparatus, and able to make tests of submarine cables. The salary is £300 per annum and travelling expenses. Engagement for three years and free passage out and home. Applications are to be sent to Mr. W. H. Preece, General Post Office, by 7th inst.—The Sunderland Corporation want an assistant electrical engineer at a salary of £120. Applications are to be made by 23rd inst.—A clerk of works is required by the Bristol Corporation to superintend the electrical installation at the Town Hall.

Electrical Advertising.—Some interest has been excited by the appearance on the front of the Empire Palace Theatre, in Edinburgh, of an electric signboard on which is flashed out in coloured lamps alternately the words "Empire" and "Palace." This device, brought out by Mr. W. F. King, of Messrs. King and Co., Leith, consists of a large board forming a dark background, on which are mounted several groups of coloured electric lamps. To these current is supplied from the dynamo which lights the building itself. The groups of lamps, to the number of 130, are intermingled one with the other, some of the lamps being used for both words in common, and the whole is lighted in such a way that one word appears in the position previously occupied by the other. The general effect of the arrangement is striking.

Plant for the Transvaal.—Speaking on Monday at the ninth ordinary general meeting of the Transvaal Gold Exploration and Land Company, Limited, held at the Cannon-street Hotel, Mr. W. M. Farmer (the chairman) said: "One thing most important is increased primary power. There is a splendid river running through the property, and we can tap it higher up and treble the present power. We can, by means of electricity, convey the power to the various positions of the property where we hope we shall be justified in erecting new stamps. For this we are now awaiting surveys and specifications for piping for a new race. The work will be put in hand whenever the specifications arrive, and when we are provided with the power we can then undertake to deal with the low-grade ore, of which there is a large quantity available."

Mersey Railway Company.—In accordance with the Standing Orders of Parliament, the Mersey Railway Company has deposited a copy of its Bill for next session in the Private Bill Office of the House of Commons. The Bill, which contains 18 clauses, seeks power to raise £50,000 additional debenture stock, ranking equally with the existing £275,000 4½ per cent. first debenture stock. This new stock is required for the purpose of providing a station for generating electricity, and for purchasing the necessary appliances for working the railway by electrical power. The Company also asks Parliament to authorise it to create a further amount of £150 000 first debenture redemption stock, for the purpose of redeeming the existing debenture stock of the Company. This stock is to be in addition to the £600,000 of similar stock which was authorised to be raised for the same purpose by Section 26 of the Mersey Railway Act of 1888.

Temporary Electric Lighting —On the occasion of the ball which was given in honour of the *début* of Lady Helen Stewart, at Wynyard Park, on Thursday of last week, the electric light was very much in evidence, being used with the most successful and brilliant effect. The ordinary installation at the Hall numbers no less than 1,200 lamps, and this was supplemented on the evening in question by a temporary installation of about 400 extra incandescent lights, whilst four 2,000-c.p. arc lanterns were also put on for external illumination, chiefly the north front of the Hall, where guests alighted. All this was done without extra engine power being required. thus showing the advantage of the duplicate method of working. The permanent and temporary installations were laid down by Messrs. Drake and Gorham, of Princes-mansions, Victoria-street, London S W. Mr. Drake, junior, of the firm, and Mr. Jenkins, the resident electrical engineer at Wynyard Park, superintended the lighting arrangements. Messrs. Drake and Gorham have a commission from Lord Londonderry to light his lordship's town house, Londonderry House, Park-lane, by an installation of about 1,000 lamps.

Leeds.—The City Council resolved at its meeting in October last to authorise the Corporate Property Committee to make an arrangement with the Yorkshire House-to-House Electricity Company for the supply of electric light for the Town Hall and Municipal Buildings for a period of two years. It was stated that the electric lighting plant at the Municipal Offices was obsolete, and it was considered advisable to obtain a supply from the House-to-House Company rather than lay down new machinery. A draft agreement with the company was afterwards submitted to the committee and approved, but the committee did not agree to the proposed insertion by the company of a minimum quantity to be paid for by the Corporation. This led to an interruption of the negotiations, and on Monday last the Corporate Property Committee met, under the presidency of Alderman Sir Edwin Gaunt, to consider the question of laying down new electric lighting plant at the Municipal Offices. Instead of considering this business, however. the committee authorised Sir Edwin Gaunt and Councillor J. Green Hirst (chairman of the Corporate Buildings Sub-Committee) to enter into further negotiations with the House-to-House Electricity Company, who, it was understood, might be willing to modify their previous proposal.

Ealing.—The Local Board at their final meeting received a letter from Messrs. Cornforth and Reacher, Mansion House-buildings, London, with reference to the loan of £26,000, at 3½ per cent. interest, required by the Board for electric lighting and other purposes. Messrs. Cornforth and Reacher offered to supply this money at a commission of three-quarters of 1 per cent., they bearing the legal charges associated with the loan. Mr. Baker Hays, in moving that the offer be accepted, remarked that it was the best offer the Board had had, and in view of the fact that by the action of the Local Government Board the Board were precluded from issuing stock or debentures he recommended its acceptance by the Board. Mr. Green seconded the motion, which was carried, subject to the brokers out of the commission named paying for the stamps and defraying the legal charges incidental to the loan. The Electric Lighting Committee reported that up to the present date 64 applications had been received for private installations of the electric light, involving a supply of

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4,033 8 c.p. lamps. Of these requested connections, 50 had been made, with a total of 2,684 lamps; the remainder, it was expected, would be put in connection in about three weeks. The street arc lamps erected and working numbered 44 out of 70; it was anticipated that by the end of the week six more would be erected and working, making 50 in all.

Glasgow.—The growth of the electric lighting scheme of the Corporation has been greater during the year than the most sanguine of its promoters expected, and it is probable that a second supply station will have to be put under way at no distant date. Nearly all the important buildings in the central districts of the city are provided with electric light either in connection with the Corporation supply or from their own installations. In some cases both connections are made. Electric motors, it is reported, are now used in Glasgow for driving ventilating fans, sewing-machines, and other light machinery. A great expansion has taken place in ordinary electric lighting business beyond the limits of the Corporation supply. In the West of Scotland, Messrs. Wm. Baird and Co have been pioneers in the adaptation of electric plant to coal-mining. Messrs. John Watson and Co, the Bent Colliery Company, the Coltness Iron Company, the Merryton Coal Company, the Carron Iron Company, and others are now applying electricity underground to such purposes as pumping, hauling, coal-cutting, etc. An installation of electric light has been fitted up in the new buildings of the Sun Fire and Life Insurance Company in Glasgow, the current being supplied by the Corporation, and an electric hoist gives easy access to the upper floors. The sub-committee appointed to consider the advisability of electrically controlling a series of public clocks by a system have held a meeting, at which a report was given in by Prof. Becker, of the university, giving details how such a system could be worked out, and after considering the same it was agreed to instruct him to make the necessary tests to ascertain the efficiency of the scheme proposed.

Tunbridge Wells.—The Callender Bitumen and Cable Company, Limited, of 101, Leadenhall-street, E.C., who are the makers and contractors for laying the underground mains, recently commenced operations. A start was made with the laying of the cables opposite Mount Ephraim House, and the work is being continued along the Mount to the junction at London-road. Messrs. Callender's resident engineer is Mr. Henry Schiassi. The type of mains adopted is concentric lead, sheathed and armoured, the dielectric itself being jute fibre impregnated with bitumen under heavy pressure. The mains are laid direct into the ground, the cables possessing sufficient mechanical strength necessary to withstand all ordinary rough usage and heavy traffic without injury. The great advantages arising from the use of this solid buried system of cables are the ease, rapidity, and economy with which the laying can be effected. The mains will be continued down the London-road to the Kentish Corner. The work will then be commenced from the electric light station, up Stanley-road to the Camden-road, turning into Calverley-road, terminating at the junction with Mount Pleasant. It is then continued down Mount Pleasant-road to the High-street, by the Kentish Corner, thence through the London-road to the Pantyles, terminating at the further end near the pump-room. A main will also be laid through the Monson-road, connecting with the cable in Mount Pleasant. Another main will start from the corner of Calverley-road, up Grosvenor-road to its junction, near the fountain, with Mount Ephraim. There will be four sub-stations, and as at present arranged, these will be at Waymark's corner, about midway down Mount Pleasant-hill, the centre of High-street, and on the Pantyles. It is expected that the work of laying the mains will be completed about the middle of next month.

Islington.—On Thursday last week Mr. Samuel Lambert, chairman of the Electric Lighting Committee of the Islington Vestry, laid the foundation-stone of the central station which is to be built at the west end of Eden-grove, Holloway, adjoining the Great Northern Railway. Mr. G. W. Clarke, chief clerk to the committee, stated that the station buildings now in course of erection by Messrs. Macfarlane, of 171, Hornsey-road, are to be completed in accordance with the designs of Mr. A. H. Tiltman, F.R.I.B.A., who has been appointed architect of the work. The contract for the supply of structural iron and steel work has been placed in the hands of Messrs. R. Moreland and Sons, of Old-street. The station, when completed, will cost about £22,000, including white brick facings throughout. The freehold site was purchased from the Great Northern Railway Company, and is situated in the rear of Burnard-place, and comprises about three-fourths of an acre. It is admirably suited to the requirements of the work, a coal siding being constructed on the site, which will enable the necessary fuel to be delivered without extra cost for cartage, a great saving on this head being consequently effected. The Vestry has entered into contracts with Messrs. D. Adamson and Co., of Dukinfield, near Manchester, for the supply of Lancashire boilers, and engines for driving alternators, etc.; with Messrs. Babcock and Wilcox, of 147, Queen Victoria-street, for water-tube boilers; with Messrs. J. Fowler and Co., of Leeds, for alternators, exciters, main switchboard and switches; with Messrs. Elliott Bros., for testing and other instruments; with the British Insulated Wire Company, for street boxes, conduits, etc.; with the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, for cables; and with Messrs. Ferranti, for the arc lighting machinery. Considerable progress has been made in laying the conduits for the cable, about one-third of the compulsory area (which extends from Finsbury Park to the Angel) being covered. The installation is being carried out under the superintendence of Mr. Albert Gay, the Vestry's electrical engineer, who has held the appointments of manager and chief engineer to the House-to-House, the Eastbourne, and the Brighton Companies.

PROVISIONAL PATENTS, 1894.

DECEMBER 17.

24499. **Electric apparatus for conveying and passing currents of electricity, induced, continuous, or currents of high frequency through footboards and oar handles and the bodies of rowers in lifeboats or other boats.** Edmond Savary d'Odiardi and Eva Savary d'Odiardi, 218, Gloucester-terrace, Hyde Park, London.

24500. **Electrodes for conveying different currents of electricity through ladders, trapeziums, wheels, running tracks, dumb-bells, and any other gymnastic apparatus, and through the bodies of those who use them.** Edmond Savary d'Odiardi and Eva Savary d'Odiardi, 218, Gloucester-terrace, Hyde Park, London.

24516. **Improvements in or relating to indicators or telegraphs for hotels, ships, offices, private houses, and for other purposes.** Richard Bowes, 6, Lord-street, Liverpool.

24534. **Velocipedes provided with electrical communicating apparatus.** Raphael Hermann Wolff, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24541. **Method of and apparatus for effecting electrolysis.** Carl Kellner, 46, Lincoln's-inn-fields, London.

DECEMBER 18.

24551. **Improvements in electricity meters.** Percy Collinson, Sunbridge-chambers, Bradford.

24564. **Improvements in and connected with electro-locomotives.** William Edwin Heys, 70, Market-street, Manchester. (Jean Jacques Heilmann, France.) (Complete specification.)

24583. **Improvements in electric heaters for cars.** George Herbert Whittingham, 52, Chancery-lane, London. (Complete specification.)

24613. **An improved electric signalling system.** William Phillips Hall, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24625. **Improvements in electric safety appliances for railroads.** Edward Levi Orcutt, 18, Buckingham-street, Strand, London. (Complete specification.)

24630. **Process of and apparatus for dissociating soluble salts by electrolysis.** Henry Spencer Blackmore, 40, Chancery-lane, London. (Complete specification.)

24638. **An improvement in or connected with binding screws for electric conductors.** Rudolf Pelargus, 115, Cannon-street, London.

24639. **Improvements in method and apparatus for purifying liquids magnetically, to which may be added electrolysis and aeration.** John True Harris, 115, Cannon-street, London. (Complete specification.)

DECEMBER 19.

24701. **Improvements in electrically-driven hoists or lifts.** Tangyes, Limited, and Arthur Bryce Mees, 7, Staple-inn, London.

24714. **Improvements in secondary voltaic batteries.** Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London.

24732. **Improvements in and connected with the reproduction of objects by the aid of the electric current.** Francis Ignatius Ricarde-Seaver and Leon Pernot, 55, Chancery-lane, London.

24738. **Electrical ventilator for ducts, pipes, street boxes, transformer-chambers and other confined spaces used for or in connection with electrical mains and other electrical apparatus.** Ernest Matthew Lacey, 19, Old-Queen street, Westminster.

DECEMBER 20.

24745. **Detachable ornamental fibrous plaster covers for electric light ceiling fittings.** Francis James Curley, 49, Flood-street, Chelsea, London.

24747. **Improvements relating to electric spring connectors.** Leon Harry Cline, Buddle-street, Wallsend-on-Tyne.

24770. **Improvements in and relating to manholes and manhole covers for underground conduits and culverts, transformer-chambers, &c.** George Henry Cottam, the Electricity Works, Hanley, Staffs.

24796. **Improved electric igniting apparatus.** Anton Findenigg and Julius Schwartz, 28, Southampton-buildings, Chancery-lane, London.

DECEMBER 21.

24864. **Improvements in the construction of primary electric batteries in order to make them portable when charged, with improved methods for carrying same, being especially adapted for use on the person, cycles, carriages, and the like kind.** Frederick Arthur George Cassell, Blackhorse-road, Deptford, London.

24873. **Improvements in telephones.** William Phillips Thompson, 6, Lord-street, Liverpool. (The Actien-Gesellschaft für Fernsprechpatente, Germany.)

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24876. **An improved apparatus for electrically winding up a driving spring.** Hermann Aron, 6, Lord-street, Liverpool.

24899. **An improved dynamometer.** Louis Schuler, 4, South-street, Finsbury, London. (Complete specification.)

24924. **Improvements in telephone switchboard plugs.** James Taylor, Heathercliffe, Helsby, near Warrington.

24926. **Improvements in dynamo-electric machines.** Alexander Bewicke Blackburn and William Buchanan, 47, Lincoln's-inn-fields, London.

DECEMBER 22.

24934. **An improved quick-break or make-time switch.** Henry John Wagg, 2, Adelaide crescent, Hove, Brighton.

24951. **Improvements in safety fuses or cut-outs for electric circuits.** Henry Bleckly Bourne and Walter Fox Bourne, 41, Priory-road, Bedford-park, London.

25014. **Improvements in electrical batteries specially applicable for use in connection with portable electric lamps.** William Herbert and Joseph Herbert, 56, Sanscroft-street, London.

DECEMBER 24.

25031. **Improvements in electricity meters.** George Hookham, 18, Southampton-buildings, Chancery-lane, London.

25066. **Improvements in electromagnetic devices for varying the self-induction of any electric apparatus, also applicable to dynamos and motors.** Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

25074. **Process and apparatus for the production of zinc and lead by electrolysis of the melted chlorides.** Richard Ottokar Lorenz, 28, Southampton-buildings, Chancery-lane, London.

25076. **Improvements in or relating to telegraphic transmitters and recording apparatus therefor.** Alfred Julius Boult, 323, High Holborn, London. (Charles Spiro, United States.) (Complete specification.)

25079. **Improvements in or relating to telegraphic transmitters and recording apparatus therefor.** Alfred Julius Boult, 323, High Holborn, London. (Charles Spiro, United States.)

25080. **Improvements in or relating to the separation of metals by electric action.** Thomas T. Oliver, 323, High Holborn, London. (Complete specification.)

DECEMBER 27.

25132. **A method of and means for economically producing electricity.** Jules Célestin Dagoneau, 53, Chancery-lane, London.

25142. **Improvements in the means for fixing electric conductors to walls and other supports.** Hugo Bremer, 433, Strand, London.

25145. **Improvements in the production of copper by electrolysis, and in apparatus employed therein.** John Clayton Mewburn, 55, Chancery-lane, London. (La Société L'Electrolyse, France.)

DECEMBER 28.

25197. **Improvements relating to the charging materials for primary and secondary galvanic elements.** Gustav Platner, 22, Glasshouse-street, Regent-street, London.

25215. **Improvements in electrically-propelled vehicles.** Henry Henry C. Baker and Heber Stone, Times Building, Junction Main and Delaware streets, Kansas City, Mo., U.S.A. (Complete specification.)

25221. **Improvements in dynamo-electric generators and motors.** Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

25231. **Incandescent electric lamp gauge.** Robert Dunbar Radcliffe and Charles Lewis Philips, 20, Abchurch-lane, London.

DECEMBER 29.

25263. **An improved arrangement of electric call-bell or alarum.** Remigius Rogg, 166, Fleet-street, London.

25264. **Improvements in electric or galvanic batteries.** Joseph Baxeres Torres, 13, Golden-square, London.

25285. **Improvements in the production of electrical illuminative effects especially applicable for exhibition upon the human body and also for illuminative stage and scenic effects in theatres and the like.** George Frederick Kenyon and Walter Reynolds, 321, High Holborn, London.

25289. **An improved primary battery.** Valdemar Ludvigsen, 4, South-street, Finsbury, London. (Complete specification.)

DECEMBER 31.

25312. **An improvement in the construction of electric arc lamps.** Harry Hewitt and Andrew Casey, 2, North Wharf-road, Paddington, London.

25340. **An improved system of conducters for electrical-decomposing tanks.** John Leith and the Electro-Chemical Company, Limited, 6, Bream's-buildings, Chancery-lane, London.

25344. **Improvements in safety devices for electrical circuits.** Walter Claude Johnson and Louis John Steele, 28, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1890.

20425. **Motors.** Von Dolivo-Dobrowolsky. (Allgemeine Elektricitäts-Gesellschaft.) (Second edition.)

1891.

40. **Electricity meters.** Hookham. (Second edition.)

1893.

18403. **Inter-communication by telephone.** Mann.

23669. **Electrolytic vessels for primary and secondary batteries, etc.** Schoop.

23687. **Telegraphy.** Delany.

24254. **Electric switch.** Nalder and others.

24414. **Electric railways.** Thompson. (Rast.)

1894.

46. **Electrically controlling single lines of railway.** Sykes and Evans.

494. **Working metals electrically.** Thompson. (Coffin.)

546. **Electric telephony and telegraphy.** Muirhead and Green.

1087. **Electric haulage.** Thwaite and Cawley.

1788. **Electric glow lamps.** Bayly. (Wiklund.)

1810. **Electrical measuring instruments.** Holt.

2548. **Electrical contact-makers.** Keeson.

2623. **Regulating and controlling dynamos.** Mordey.

2733. **Electric arc lamps.** Mountain and Carew.

2965. **Incandescent electric lamp-holders.** Geisenheiner and Lessing.

3166. **Electric traction.** Howard. (Simon and others.)

3426. **Electric lamps.** Hunter and Jack.

4235. **Electric lamp fitting for pianofortes.** Ewart.

11280. **Jointing electric conductors.** Geipel.

11601. **Printing-telegraph instruments.** Kleber.

13579. **Coin-controlled electrical apparatus.** Frost.

18057. **Carbon regulator for arc lamps.** Zausmer.

20886. **Telegraphic relays.** MacDonald.

21250. **Multiple telegraphic apparatus.** Piedfort.

21347. **Telegraphic or telephonic exchanges.** Childs.

21461. **Electric motors.** Riordon.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅛-6
Bournemouth Electric Company	—	—
Brush Company, Ordinary	2	2⅛-2⅜
—— Nom. Cum., 6 per cent. Pref.	2	2⅜-2⅝
—— 4½ Debenture Stock	100	111-114
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	15-15½
—— 5 per cent. Debenture Stock	115	130-133
City and South London Railway, Consolidated Ordinary	100	43-45
—— 4 per cent. Debenture Stock	100	124-126
—— 5 per cent. Pref. Shares	10	13⅞-14½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	3-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	97-102
Electric Construction, Limited	2	½-½
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1½-1½
Elmore's French Company	2	1/16-3/16
Elmore's Wire Company	2	1½-1⅝
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	8½-9½
—— Preference	—	12
House-to-House Company, Ordinary	5	2½-2⅝
—— 7 per cent. Preference	5	6⅛-6⅝
India Rubber and Gutta Percha Works	10	25½-26½
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge	5	4½-4⅝
—— 6 per cent. Pref.	—	6½-6⅝
Liverpool Electric Supply, Ordinary	5	7 5/16-7 7/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8⅞-9
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	⅞-1⅛
Metropolitan Electric Supply	10	10-10½
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	5⅛-5⅜
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-6
—— 4½ per cent. Deb. Stock	—	110-113
Notting Hill Company	10	7⅛-7⅞
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	—	7-7½
—— £4½ shares	—	5½-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅜-8½
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7⅛-7⅞
Yorkshire House-to-House	4½	4⅛-4⅜

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NOTES.

Fulham.—The Library Commissioners of the Fulham Vestry have sent us a copy of their seventh annual report (1893-94).

Electric Call System.—It is proposed to establish an electric call system in Brighton in connection with the local post offices.

City and South London Railway.—A writer in a railway journal suggests that this line should be extended to Clapham Junction.

Light Railways.—A paper on this subject by Mr. W. M. Acworth appears in the *Journal* of the Royal Agricultural Society for December.

Church Tower Struck by Lightning.—A few days ago the tower of St. Columb Church, Cornwall, was struck by what is described as a thunderbolt.

Change of Address.—Mr. James Swinburne, of 4, Hatherley-road, Kew Gardens, informs us that he has removed to 66, Victoria-street (2, Princes-mansions), S.W.

Art Furniture Exhibition.—It is intended to hold the third annual exhibition in connection with the above trade in April next, at the Royal Agricultural Hall. The City offices are at 64, Finsbury-pavement, and the manager Mr. G. D. Smith.

Northern Society of Electrical Engineers.—The members of this society will meet on Monday next, the 14th inst., at the Palatine Hotel, Hunt's Bank, Manchester, at 8 p.m. Mr. Henry Edmunds will deliver his presidential address.

Oil-Engine Trials at Cambridge.—The *Journal* of the Royal Agricultural Society contains the report by Prof. D. S. Capper, M.A., of the trials of oil-engines at Cambridge. The report is illustrated, and deals fully with the tests of the various engines tried.

Madras Electric Tramways.—It is stated that this electric tramway, which has been equipped by the Electric Construction Company, was recently set in operation. The system adopted is of the open-conduit type, somewhat similar to the method employed in Budapest.

Matchbox.—By this we do not refer to the racehorse of this name, but to an earthenware matchbox, which has been kindly sent us by the General Electric Company. As the editor does not smoke, he has handed over the matchbox to his assistants for their use—as a paperweight.

Electric Bells.—A new department—namely, the manufacture of electric bells—has recently been added to the business of the Electrical Company, Limited, of 122 and 124, Charing Cross-road, W.C. The company have now issued a price list of the different kinds of electric bells they supply.

Lectures on Dynamo and Transformer Construction.—Commencing with yesterday (Thursday), Mr. James Swinburne began at the Electrical Standardising, Testing, and Training Institution, Faraday House, Charing Cross-road, a series of lectures to the students on "Dynamo and Transformer Construction."

Catalogue of Boilers.—The Cradley Boiler Company, of Cradley Heath, near Birmingham, have sent us a copy of the second edition of their catalogue of boilers. These include those of the Lancashire and Cornish types, horizontal and vertical multitubular boilers, and donkey, semi-portable, locomotive, Galloway, and launch boilers.

Students of the Institution.—A students' meeting of the Institution of Electrical Engineers will be held in the library of the Institution, 28, Victoria-street, on Friday next, the 18th inst., at 8 p.m. A paper will be read on the following subject: "Electrical Transmission of Power (with Special Reference to Mining Operations)."

Trades, Industries, and Arts Exhibition.—It is intended to hold an exhibition at the People's Palace, to be opened in November, 1896, of the arts, trades, industries, and handicrafts existing in the eastern and other industrial districts of London. The hon. secretaries are Messrs. Harold Boulton and Ernest Flower, and the offices are at 64, Cannon-street.

Society of Arts.—On Monday next, at 8 p.m., the first Cantor lecture on "The Arc Light," by Prof. Silvanus P. Thompson, D.Sc., F.R.S., will be delivered. It will deal with the discovery of the electric arc light, early experiments, and the physics of the arc. On Wednesday next, at 8 p.m., a paper will be read on the "Commercial Synthesis of Illuminating Hydrocarbons" by Prof. Vivian B. Lewes.

Electric Motors in France.—A Parisian dealer in sewing-machines in Paris is exhibiting small apparatus showing the utility of electric motors. One of these consists of a sewing-machine driven electrically, one of the best known of the uses of electric motors. The second is an electric churn, in which butter is made in from twenty to thirty minutes. The third is a boot-brushing machine, and the fourth a set of revolving brushes for sweeping the floor.

Behind the Times.—According to our New York contemporaries, the first direct-connected arc light station in the United States was started on December 17 at the Mutual Electric Light and Power Company's plant in Chicago. The new plant consists of a Willans engine connected directly to a 125-light Brush arc dynamo running Brush-Adams lamps. This is stated by our contemporaries to mark a new era in electrical progress. Chicago is behind the times.

Engineering and Machinery Diary. — Messrs. Charles Straker and Sons, Limited, Bishopsgate-avenue, E.C., send us "The Engineering and Machinery Diary," compiled by Mr. J. S. Jeans. In addition to the usual matter in a diary, this compilation contains various formulæ, tables, etc., of an engineering character; a directory of engineers—or, rather, of some engineers, the method of whose selection is not obvious; postal and miscellaneous information.

Code Telegraphy.—The decision arrived at at the last meeting of the International Telegraph Conference (Paris, 1890) resulted in the International Telegraph Office at Berne being entrusted with the duty of preparing a vocabulary of words, for use in code telegrams passing between European countries, to become obligatory three years from the date of publication. This vocabulary has now been issued, containing over 250,000 words, and a copy of it may be inspected on application at the Information Department of the London Chamber of Commerce, Botolph House, Eastcheap, E.C.

Modern Journalism.—On August 3 last we described in our "Notes" an electrically-lighted lifebuoy which had been brought out by the Allgemeine Elektricitäts-Gesellschaft, of Berlin. It took four months for the *Globe* to get this item transferred to its columns, where it appeared early in December. The *Echo*, whose earliness of information must make it a most formidable rival to the other London evening papers, only made the discovery that such an invention existed on Tuesday last. Its comment on the matter is that the buoy should "have a future before it.' It could not well have a future behind it.

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Casings and Covers.—Promptness is the characteristic of the new price list of electric light cable casings and covers issued by Messrs. McGaw and Co., of York-road, Lambeth, S.E., the list being for January of the present year. It shows a variety of casings both reeded and moulded, and of widths varying from 1¼in. to 5¾in. for the accommodation of ·190 cable and 1·500 cable respectively. There are also "Appendo" mouldings for hanging pictures, but which can also be used as covers for casings.

Temporary Ship-Lighting.—The Caen Chamber of Commerce have had before them the subject of the lighting of vessels passing through the Caen Canal to the sea. A local electric light company has offered to undertake, at its own risk, the electric lighting of the ships, subject to a subsidy from the Chamber of £24 per annum for five years. This has been agreed to. The company engage during that period to have a service of five batteries of accumulators, each with a 200-c.p. projector. They will charge vessels at the following rates: up to 600 tons, £1. 8s.; 600 to 800 tons, £1. 12s.; 800 to 1,000 tons, £1. 16s.; and 1,000 tons and upwards, £2.

African Trans-Continental Telegraph.—A Reuter's message from Cape Town, dated 7th inst., states that the Portuguese have ceased to obstruct the progress of the African trans-continental telegraph, and the line is expected to reach the Zambesi this month. A Central News message from Cape Town, dated 8th inst., announces that the telegraph system of Southern Africa is now working as far as Blantyre. Messages were sent through to that station from Cape Town the previous day. The line would have been opened earlier but for the difficulties thrown in the way by the Portuguese. All these obstacles have now been satisfactorily overcome.

Institution of Engineers and Shipbuilders.—The fourth general meeting of the North-East Coast Institution of Engineers and Shipbuilders will be held in the lecture hall of the Literary and Philosophical Society, Newcastle-upon-Tyne, on Tuesday next, the 15th inst., at 7.30 p.m. The business will include the reply of Mr. A. Young to the discussion on his paper on the "Rolling of Ships"; discussion on Mr. F. Caws's paper "On Ship Acceleration and Fluid Resistance"; and a paper will be read on "The Design and Efficiency of Plant for the Transmission of Power by Electricity," by Mr. W. C. Mountain, member of council.

Royal Meteorological Society.—Two meetings of the society will be held at 25, Great George-street, Westminster, on Wednesday, the 16th inst. The first will be an ordinary meeting for the election of fellows and the transaction of ordinary business, and will commence at 7.30 p.m. At it the following paper will be read: "The Gale of December 21-22, 1894, Over the British Isles," by Mr. Charles Harding, F.R.Met.Soc. At 8.15 p.m., the annual general meeting will commence, when the report of the council will be read, the election of officers and council for the ensuing year will take place, and the president (Mr. R. Inwards, F.R.A.S.) will deliver an address.

Australian Cable Contracts.—It is intended to hold an inter-colonial conference on February 12 to consider the situation created by the decision of the Victorian Government to withdraw from the guarantee given to the Eastern Extension Telegraph Company by all the Australasian colonies except Queensland, and in virtue of which the charges for cable messages were materially reduced. The Postmaster-General expresses the opinion that the colony's withdrawal from participation in the cable subsidy will not render it necessary for the Eastern Extension Telegraph Company to raise the tariff for the transmission of messages to the old figure. Pressure is, however, being brought to bear by New Zealand and the other colonies to induce the Victorian Government to reconsider their decision.

Patents in 1894.—In an article contributed to the *Law Journal* it is stated that the number of patents applied for last year was 25,372, an increase of about 250 over the preceding year. Omitting parts of 100, the figures since 1885 are as follows, the first figure after the date of the year representing applications, and the second the number of successful oppositions: 1886, 17,100, 46; 1887, 18,000, 83; 1888, 19,100, 54; 1889, 21,000, 28; 1890, 21,300, 36; 1891, 22,800, 34; 1892, 24,100, 16; 1893, 25,100, 29; 1894, 25,300, —. As a rule, some 46 per cent. of the total applications are completed, and, although the increase in the number of applications has not been so great in 1894 as in former years, yet it will prove that the number of completed applications will be beyond the average.

English Tramways.—A parliamentary return issued on Wednesday, giving statistics of the various tramway undertakings in the United Kingdom for the year ended June 30 last, shows an increase in every department, more particularly in expenses. The total capital authorised for street and road tramways up to the date named was £17,743,035, being an increase of £813,903 as compared with the previous year. The number of miles of line open had increased by 15, to 975; the number of horses owned by 303, to 30,528; the number of locomotive engines by 1, to 564; the number of cars by 81, to 4,179; and the total number of passengers carried by 18,683,321, to 616,972,830. The gross receipts, it appears, were only augmented by £9,742, to £3,615,837, while the working expenses increased by £21,610, making the net receipts less by £11,868 than for the year 1892-3.

Water Power for Electric Lighting.—Some three and three-quarter miles from Dieppe is the small town of Arques-la-Bataille, which has recently been provided with a central electric light station. The site chosen is at an old mill, 1,100 metres from the centre of the town, and both public and private lighting is carried out. The water power utilised is that of the River Béthune, and the fall of water is 6ft. The old under type of wheel has been replaced by a Hercules turbine of 38 h.p., which, at a normal speed of 77 revolutions, drives by means of gearing a horizontal shaft, the speed of which is 200 revolutions. From this shaft is actuated by means of belt and pulleys a second shaft running at 400 revolutions, and from which the dynamos are operated. The dynamos, of which there are three, are of the Postel-Vinay type, and several hundred lamps are supplied from the station.

Electric Traction in Spain.—A few weeks ago we announced that the Allgemeine Elektricitäts-Gesellschaft, of Berlin, had entered into a contract for the conversion of the Bilbao-Sansurce horse tramway into an electric line. Since that time a company has been formed to work this tramway and another line on the opposite bank of the Ria. It is also intended to substitute electric traction on the latter for the existing system, and negotiations for this purpose are already in progress. The total length of the two tramway systems is approximately 19 miles, and it is intended to operate both lines by means of 28 cars. Of these, 17 will be equipped with two motors of 25 h.p. together, and the remainder with one motor of the same power. In addition to these, there will be eight cars solely used for the transport of merchandise. It is proposed to set the two lines in operation next August.

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Waterloo and City Railway.—This line is making satisfactory progress. At the staging near Blackfriars two shafts have been driven right down into the London clay, and four great "shields" have been got into position and are being driven across in both directions, two of them burrowing their way along in the direction of the City, and two towards Waterloo. Somewhere about a hundred yards of the tunnel has thus been constructed towards the City, and about half that length in the opposite direction. The rest of the river portion of the work will probably proceed smoothly and rapidly. The work is all through London clay, which is more like a very soft rock that is easily bored. The more difficult part of this undertaking will be met with when the tunnel emerges from under the river on the southern bank. A watery gravel will here be encountered, necessitating a revert to pneumatic pressure as a means of keeping out the water while the tunnels are driven through.

Are Horses Doomed to Disappear?—A representative of a contemporary paid us a visit the other day in great anxiety as to the ultimate fate of horses now that electric traction is coming more prominently to the front. He assured us that during the past five months no less than 5,000 horses which had previously been engaged in tramway working in the United States had been landed at a Scotch port, and that although they were not sent to England, as American cattle sometimes is, as "prime Scotch beef," yet they had a depressing effect upon the prices of horses in this country. We of course expressed sympathy with our friend, who, continuing, asked whether it was possible that electric traction would develop in England proportionately to the same extent as in the United States, and whether electric cars would supersede 'buses, carts, and brewers' wagons. As we are not among the prophets, we had to refrain from predicting the future.

South African Exhibition.—It is proposed to hold a South African exhibition at the Crystal Palace during May-October. The council are satisfied that there exists a sufficient amount of support to warrant the carrying out of the proposed scheme. They recommend to the land, mining, and industrial companies of South Africa, to manufacturers, merchants, and others interested in the trade of that country, the advisability of their being represented at the forthcoming exhibition. The council are satisfied that this exhibition presents a *bonâ fide* opportunity for displaying in a thoroughly genuine and efficient manner the produce and resources of South Africa, and is therefore deserving of the serious consideration and support of all undertakings and persons associated with the trade of that country. It has been determined to defer the allotment of space till the end of January, by which time it is hoped that intending exhibitors will have sent in their applications to the Crystal Palace Company.

Electric Lighting in France.—It has been decided to erect a central electric light station at Cazères, Haute-Garonne.—The Luneville Municipality have made an agreement with Madame Jeanmaire for the electric lighting of the town.—A petition has been presented to the Marseilles Municipality for an extension of the electric light mains.—Messrs. Passot and Vergnes have applied to the Municipality of Morez for a concession for a central electricity station in that town. The Municipality of Cambrai, Nord, want tenders for the gas and electric lighting of the town.—The village of Montbozen, Haute-Saône, has only between 500 and 600 inhabitants, but a central electric light station has been completed there.—Messrs. Laroudie and Co. are desirous of obtaining authority to establish a central electricity station and an electric tramway at Périgueux.—A concession has been granted to Mr. Emilien Beaufumé for the establishment of a central station at Vermonton, Youne, a town of 2,000 inhabitants.

Electric Flash-Lights.—The scene of disembarkation of the passengers on the "Empress," which was run aground a few days ago at Calais, was sufficiently picturesque. It was dominated, a correspondent states, by the splendid light of the Calais Lighthouse, with its relentless four flashes and a pause, lighting up the dark ramparts of the fortifications and the belt of smooth wet sands fringed by the white foam of the breakers, and throwing into relief black heaps of wreckage which had drifted from the pier. At the foot of the ladder was collected a noisy mob of excited Frenchmen with two or three lanterns, ruddy in contrast with the electric light. The wind was very high and splashed a sleety rain in passengers' faces. But it must be said that, for healthy persons at least, there was no serious difficulty, or even inconvenience. By half-past 10 the passengers were ashore with their hand baggage, and on the whole the experience may be described as a shipwreck made easy.

Danger of Welsbach Lights.—The following is given by the New York *Electrical Review*: "'Those Welsbach gaslights made a good deal of trouble in my family,' observed a prosperous merchant. 'In my library I have a gas-jet set low down over a couch on which I lie and read. I can't get current into my house, so I have to do as well as I can with gas. Hearing of the Welsbach light, I ordered my gas-man to put one on my reading light over the couch. The other evening I was lying reading, when, as I often do, I fell asleep. The family was out, and when they returned I was still asleep, and the Welsbach was burning full tilt. I was awakened by a chorus of screams and sobs. My wife and the girls thought I was dead. That ghastly green tinge peculiar to the Welsbach light had cast its effulgence over my countenance, and my wife said I looked exactly like a corpse. The Welsbach is gone, and I have resumed using the old gas-burner, while patiently waiting for the electric current to be supplied in my street.'"

Electric Lighting for River Steamers.—An Indian contemporary observes: All the steamers belonging to the Rivers Steam Navigation Company and the India General Company are to be fitted up with electric light so as to enable them to trail down the rivers at night. The prohibition to travel by night has been a crying grievance with the mercantile community ever since the water highways of Eastern Bengal have been overrun by steamers conveying jute, tea, and other valuable cargo to Calcutta. The rivers there are mostly broad and deep, but they are studded with shoals and sandbanks which are a standing menace to vessels travelling at night. No commander dare pursue his journey after regulation hours even with the help of a bright moon. If the above proposals are carried out it will cut short the passage considerably and greatly benefit all parties concerned. In the case of jute, the risk of the cargo catching fire will be greatly minimised, and as regards tea, it will go far towards putting an end to the bitter complaints which are constantly being heard on account of the great delays and loss occasioned to shippers under the present system.

Personal.—Mr. Stephen Sellon informs us that he has resigned his appointment with the Electric Construction Company, Limited.—Mr. W. J. Furse, electrical engineer, of Nottingham, has been elected chairman of the West Bridgford District Council. This appointment carries with it a seat on the magistrates' bench for the county of Nottingham.—Mr. A. H. Bayes has been appointed electrician to the Brymbo Iron and Steel Company, Brymbo,

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near Wrexham.—Mr. J. S. Cunnington, who has been for over 10 years chief electrical engineer and manager of the electrical department of Messrs. B. Verity and Sons, Covent-garden, has severed his connection with them.—Mr. Henry Eaton, the late superintending engineer of the metropolitan district of the Postal Telegraph Department, has been presented by his former colleagues with a handsome testimonial as a mark of their esteem. Mr. W. H. Preece, C.B, F.R.S., engineer-in-chief of the department, acted as the spokesman of the subscribers.—The council of the Institution of Civil Engineers have transferred Mr. W. B. Esson to the class of member, and Mr. J. S. Raworth has been elected a member.—The *Electrical World* of December 29 contains a portrait and biographical sketch of Mr. Gisbert Kapp.

The Fecamp Central Station.—A description is given in *L'Electricien* of December 22 and 29 of the central station erected at Fécamp, a French town having a population of 14,000 inhabitants. The plant, which was originally contained in a sawmill, at first comprised two Edison dynamos, giving 80 amperes at 115 volts, driven from a countershaft in the mill. As the demand for light increased, a battery of Laurent-Cely accumulators was installed, 700 metres from the generating plant, so as to provide an additional supply. As, however, the number of consumers increased, it was decided to erect new works on the site of an old mill in the Place de l'Hotel de Ville, where a 25-h.p. turbine was in operation. The new station contains two De Naeyer boilers and two Weyher and Richemond vertical engines, each of 85 h.p. and running at a speed of 200 revolutions a minute. In addition to these, there is a Hercules turbine, which by means of gearing drives two Edison dynamos each giving 80 amperes at 110 volts. The voltage of these two machines can be raised to 150 volts for the purpose of charging accumulators. The two steam-engines actuate two dynamos, giving 220 amperes at 125 volts. There are four sets of accumulators, each battery comprising 69 cells. Some 2,000 lamps are connected to the distributing mains.

Telephony Between Trains and Railway Stations.—A correspondent of the *New South Wales Railway Budget*, writing from New Zealand in reference to the Wellington and Manawater Railway, says: "Some interesting experiments have been made on this railway by Mr. Fulton, the engineer to the company, as to the feasibility of intercepting the telephone currents along the line in order that the guard of the train may be able to establish communication with any of the stations or with the head office in case of accident or delay to the trains anywhere upon the line. The company possesses a telephone wire running beside its line along its whole length with instruments at each station. A telephone instrument has been fitted in one of the guards' vans, and attached to it is a reel of wire, upon one end of which is an iron hook. Wherever the train may stop the guard has merely to run out his reel, and throw the hook over the permanent telephone wire, and he is immediately placed in communication with the whole of the stations and the head office, the divided current being sufficiently strong to carry both ways, and the wheels of the van and the rails contributing the necessary earth connection. For instance, the train can stop a mile from Wellington, and the guard there throws his hook over the wire, when he can be heard either in Wellington or at Longburn, and at every station between."

Internal Conduit System of Wiring.—The system of placing lighting leads in wooden mouldings in the United States in the early days resulted in a number of fires, and attention was therefore directed to the introduction of an improved system. Such a method was brought out some five years ago by the Interior Conduit and Insulation Company, of New York, of which Mr. E. H. Johnson is the president. This system, which has now become practically universal in the United States, is about to be introduced in this country by Mr. Fred Bathurst, who for the past four years has been connected with the Edison Electric Company in America, and who has just returned home. The system consists in the use of iron piping having an inner tube of asphaltic compound with paper as the base, and through which the leads are passed and readily drawn out at any time. In fact, it may be said to be the use for internal work of the underground pipe system laid in the streets for cables, together with their junction-boxes. Mr. Bathurst, who hopes to bring the merits of the system before English wiring contractors, has not yet completed his office arrangements, but enquiries may be made to his private address, 14, Greencroft-gardens, South Hampstead, N.W. We must not omit to mention that this system has already been successfully developed in Germany by Messrs. S. Bergmann and Co., of Berlin, and it is said to be rapidly becoming acknowledged in that country as the standard method of electric wiring.

Electric Lighting in Germany.—A central station has been opened at Aibling.—A mill owner at Münster proposes to use his superfluous water power for supplying current to Gaildorf, about a mile distant.—An agitation is taking place against the proposal of the Goslar municipality to establish municipal gasworks. A petition has been numerously signed against the scheme, and the authorities are being asked either to establish a central electricity station or to go on with petroleum lighting as in the past. Sixty local firms have also signed an undertaking that if a gasworks be established, they will not take any gas.—An electric lighting company is negotiating for the purchase of water power at Fraulautern to erect a central electric light station.—The new Adler Hotel, which is being built at Schönwald, in the Black Forest, is to be lighted electrically. Now other hotel-keepers, as well as manufacturers and shopkeepers, have announced their intention of adopting the new illuminant.—The Allgemeine Elektricitäts-Gesellschaft, who are preparing for the erection of a large central electric light station at Oberschönweide on the Upper Spree, propose to light various villages in the district from Treptow to Köpenick and Friederischshagen, and also to supply them with current for power purposes.—It is intended to have an electric light installation in connection with the large Rangir railway station at Nuremberg which is being erected.—Messrs. Schuckert and Co. have arranged for the establishment of a central electric light station at Goldberg.—It is proposed to establish a municipal electric station at Mayence.—Messrs. Heinrich Taaks and Co., of Stuttgart, have completed a central station for the Offenburg Colliery Company at the Berghaupten pit. Alternating current at 3,000 volts is employed and transmitted to the town of Gegenbach, Kinzigthall, a distance of three and a half miles.—Various places in the Palatinate—such as Bergzabern, Wachenheim, and Haardt—have introduced the electric light.—A project has been mooted for the electric lighting of Elmstem. Water power is available.

Gas Batteries. — An abstract is published in the *Journal* of the Chemical Society of a paper contributed by Mr. F. J. Smale to the *Zeit. Physikal Chem.* on "Gas Batteries." The E.M.F. was determined in the case of a large number of gas batteries, the electrode being usually platinum strips coated with platinum black, and immersed partly in the gas, partly in the electrolyte. Experiments were performed to test the dependence of the E.M.F. on the

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nature and size of the plates and nature and concentration of the solutions. The nature of the plates had no effect, similar results being obtained with gold, platinum, and palladium, whilst a slight variation with the size in the case of an oxygen-hydrogen chain is explained by the slight absorption of oxygen by platinum black. The E.M.F. appeared to be independent of the electrolyte and its concentration, in the case of sulphuric, phosphoric, and chloracetic acids, and also, although less certainly, with sodium and potassium hydroxides, sodium sulphate, and potassium chloride. Abnormal values were, however, obtained with the halogen acids and many salts, which the author accounts for by the existence of secondary actions. Gaseous chains of hydrogen chlorine, hydrogen bromine, and hydrogen iodine were investigated, and the effect of dilution of a gas studied by the comparison of a hydrogen-oxygen with a hydrogen air chain, the E.M.F. in the latter case being about 10 per cent. lower. The means of the result for the chains are: hydrogen oxygen, 1·044 volts; hydrogen chlorine, 1·532 volts; hydrogen bromine, 1·111 volts; hydrogen iodine, 0·530 volt. By immersing the electrodes in the same electrolyte at different concentrations, the E.M.F. between the two solutions is found, and a number of tables with these results are recorded. The E.M.F. in the oxygen-hydrogen chain falls regularly as the temperature increases, thus: 0deg. = 1·090 volts, 20deg. = 1·065, 40deg. = 1·033, 60deg. = 1·001; and from these numbers the temperature coefficient of the solution tension is calculable, giving the result $\frac{d\pi}{dt} = -0{\cdot}00140$—that is, the solution tension is inversely proportional to the absolute temperature. The E.M.F. with the similar electrode in an electrolyte at different temperatures was also observed and calculated, with fair agreement in the results.

The Heilmann System of Electric Traction.—A correspondent recently informed *L'Energie Electrique* that he had never yet been able to travel in a train hauled by the Heilmann electric locomotive, which we described early last year. That journal now publishes in its issue of the 1st inst. a copy of a remarkable circular issued by the administrative council of the company working this system. After referring to the experiments with the locomotive on the lines of the Compagnie de l'Ouest, the circular states that after trials extending over from eight to ten months, the first locomotive was put out of service. This is stated not to be due to lack of success. On the contrary, the railway company considered the results to be so satisfactory that they agreed to rent two new locomotives, but the company could not establish a regular service with a single locomotive. As a means of utilising this first locomotive, it is suggested that it might be made to serve as a central station, and that the four-wheeled bogies could be used for hauling purposes, the current to be supplied by an overhead conductor. With regard to the two new locomotives, it is mentioned that they will be of 1,500 h.p. each, capable of hauling from 200 to 250 tons at a speed of 62 miles an hour. The construction is being rapidly pushed on so that the locomotives may be placed at the disposal of the company during the present year. The contract for the supply of the boilers, bogies, and water-tanks has been placed with the Société des Anciens Etablissements Cail, that for the dynamos with Messrs. Brown, Boveri, and Co., and that for the steam-engines with Messrs. Willans and Robinson, of Thames Ditton. All these steps have been taken with the assistance of the railway company, to whose specification the contractors are working. At the time of entering into these contracts, the circular proceeds, the Heilmann Company took the opportunity of granting to Messrs. Brown, Boveri, and Co., for Switzerland, Germany, and Italy, and to Messrs. Willans and Robinson, for England, India, and the British colonies, the exclusive right of working the Heilmann patents in those countries respectively. The company, in addition to these patents, possesses others relating to navigation and to self-contained cars on rails and on roads, but it is crippled for want of capital. A means of raising fresh capital, the circular concludes, is now under consideration.

Electric Ploughing Experiments.—Some experiments in the direction of driving ploughs by electric motors have recently been made by Messrs. F. Zimmerman and Co., of Halle. The company have introduced a new kind of plough, which is illustrated and described in the New York *Electrical Engineer* of the 26th December. It appears that the plough is not pulled over the ground at the end of a wire rope, but the electric motor is mounted on the tipping plough and is carried with the plough as the latter is drawn over the field. The armature of the motor, through the medium of a chain and sprocket wheel, drives the shaft, over which passes a chain stretched along the length of the field. Both ends of this chain are fastened down securely by triple anchors. When the motor is set in operation it winds the plough over the field on the stationary chain. At the end of the field the plough is tipped and by a simple switch the motor is reversed and pulls the plough in the other direction, at the same time laying the chain sidewise for the next furrow to be ploughed. The shifting of the anchors is done by means of a crowbar, which pulls the anchor out of the ground, and the anchors are mounted on wheels so that they can be easily moved. No trouble, of course, is encountered in the operation of the plough as just described, but the drawback which has always stood in the way of the application of electricity to ploughing has been the difficulty of conducting the current to the motor with the plough travelling over the field. The usual method of conducting current to a moving motor by means of trolleys in contact with a fixed conductor was evidently out of the question here. The manner in which this important point has been provided for is exceedingly interesting. Since the plough passes to and fro for a comparatively short distance, it may be considered as the end of a pendulum bob, which is connected to the centre of oscillation by the connecting cable, so that the latter, vibrating over the field, follows the movement of the plough. In order to avoid the friction and wear on the cable as it passes over the ground, the cables are mounted on light rollers and held by clamps, the rollers following readily the direction of motion of the plough. Up to the present time the company has built two ploughs, one with two shares and one with four, both of which were put in operation in the neighbourhood of Halle. The results were most encouraging, from the standpoint both of the quality of the work and the power consumed. The two-share plough was driven by current obtained from a dynamo driven by a 10-h.p. portable engine. The earth was a heavy binding clay. The dynamo gave 110 volts and 60 to 80 amperes on an average, which would be equivalent to about 12 h.p. delivered by the engine. The plough made two furrows having a combined width of 60 centimetres and a depth of 24 centimetres. The spring dynamometer showed a pull of between 600 and 700 kilogrammes and an average of 650 kilogrammes, which would give a resistance of 49·2 kilogrammes per square decimetre of furrow cross-section. When the plough was driven at the rate of ·9 metre per second, 8 h.p. was consumed, showing a loss of 4 h.p. between the portable engine and the plough. Compared with the indirect steam plough, this was a very small loss.

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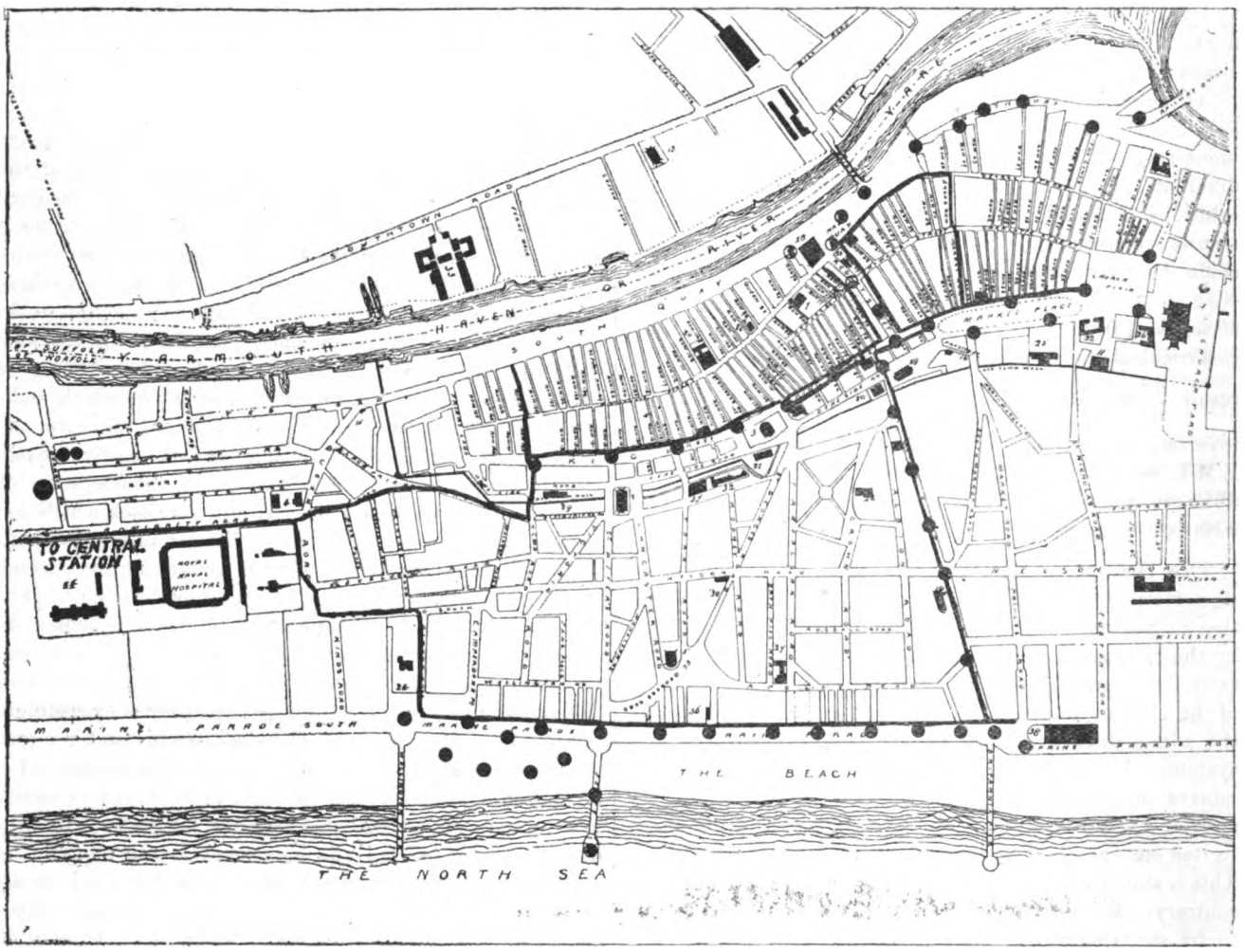
THE ELECTRICITY WORKS AT YARMOUTH.

The Town.

A favourite and attractive watering-place during the season, but dull and dreary in winter time, are the conclusions arrived at by the occasional visitor in regard to what is sometimes termed "bloater land." Yarmouth, it is scarcely necessary to mention, derives its name from the fact that it is situated at the mouth of the Yare, about 20 miles from Norwich; and its population comprises some 50,000 inhabitants, this number including those persons living on the other side of the river in Gorleston and Southtown, which form part of the borough. The latter covers an area of 4,500 acres.



Yarmouth.—Map Showing in Black Lines the Position of the High and Low Pressure Cables, and in Black Dots the Arc Lamps.

The Municipal Buildings, which were erected in Hall Quay in 1882, are of a handsome character. It is from Hall Quay that the steamers of the General Steam Navigation Company convey passengers daily during the summer to and from London. Close by are the North and South Quays. The latter is of most interest to visitors, as an agreeable promenade is afforded by an avenue of trees arranged parallel for a long distance. Vessels from different parts of the Continent and from the North of England may be seen here, unloading ice for the fishing trade, and coal, timber, corn, etc. Yarmouth is one of the largest stations belonging to the Trinity Service, and no less than 12 lightships are stationed off this dangerous coast. Passing along the Marine-parade, which fronts the beach—a lively place in the season—one comes to the promenade, the South Denes. This is known as the race-course, and is about a mile and a half in length, and being flat allows of grand field days of the volunteers being held in the summer.

An interesting and historic landmark is afforded by St. Nicholas s Church, which was originally founded in 1101, and which is said to be the largest parish church in this country. There are numerous other churches, chapels, and educational institutions. Of the places of amusement may be mentioned the New Theatre Royal and the Aquarium.

Preliminary Steps in Electric Lighting.

It cannot be said that the Corporation of Yarmouth have made undue haste in establishing municipal electricity works. It is doubtful whether the undertaking now on the point of being inaugurated would have reached this stage, or, at all events, at the present time, if it had not been for the exertions of Mr. J. W. Cockrill, A.R.I.B.A., A.M.I.C.E., the borough surveyor. As long ago as in 1889 Mr. Cockrill presented a report to the Electric Lighting Committee, and in August, 1890, the provisional order issued to the Corporation was confirmed by the Electric Lighting Orders Confirmation (No. 6) Act, 1890. A year subsequently the borough surveyor recommended that information should be obtained as to the number of persons willing to guarantee taking a supply; that an advertisement to that effect should be inserted in local papers; that the latest information, in a tabulated form, should be procured from each town in which electric lighting had been introduced; that the borough accountant should obtain information as to the financial results which had attended the working of electric light enterprises; and that a sub-committee should be empowered to visit some towns and inspect the various systems at work.

These recommendations were adopted by the Corporation, and the borough surveyor was authorised to obtain further particulars on the subject of electric lighting. Shortly afterwards Mr. Cockrill was enabled to place before the Electric Lighting Committee an admirable tabulated

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statement prepared from the information furnished, we are pleased to say, with their characteristic courtesy, by no less than 97 borough engineers and surveyors. Beyond stating that this report has formed the basis of other and similar statements, it will be unnecessary to enter further into the matter on this occasion. At the same time it unfortunately happened that the result of the local advertisements for consumers was the promise of the insignificant number of less than 200 lamps!

In the meantime the sub-committee appointed according to the above recommendation, and consisting of Messrs. F. Danby Palmer (chairman), R. Martins, H. Harvey-George, J. H. Bly, and J. W. Cockrill (borough surveyor), were making investigations. They visited the works of Messrs. Crompton and Co., the St. Pancras station, the works of Messrs. Ferranti and of the Brush Electrical Engineering Company, and the stations at Chelsea, Manchester-square, Kensington Court, and at Bradford. As a result of their personal examination, the sub-committee recommended the adoption by the Corporation of the high-pressure alternating-current system, with sub-stations, and that the borough surveyor should prepare plans and specifications for the carrying out of the undertaking.

Tenders were received from six companies, but for some reason or other not one of the offers was accepted, and the matter remained practically in abeyance for some months. In the interim the Local Government Board sanctioned a loan of £15,000 for establishing municipal electricity works. Eventually fresh tenders for the buildings and plant were invited, this being in January, 1894, and Mr. W. H. Preece, C.B., F.R.S., was called in to advise the Corporation on them. As a result the tenders of Messrs. Crompton and Co., Limited, of Mansion House-buildings, London, E.C., and of Chelmsford, for the supply and erection of the whole of the plant, and of Messrs. J. F. W. Bray, of Yarmouth, for the erection of the station buildings, were accepted.

The Adopted System.

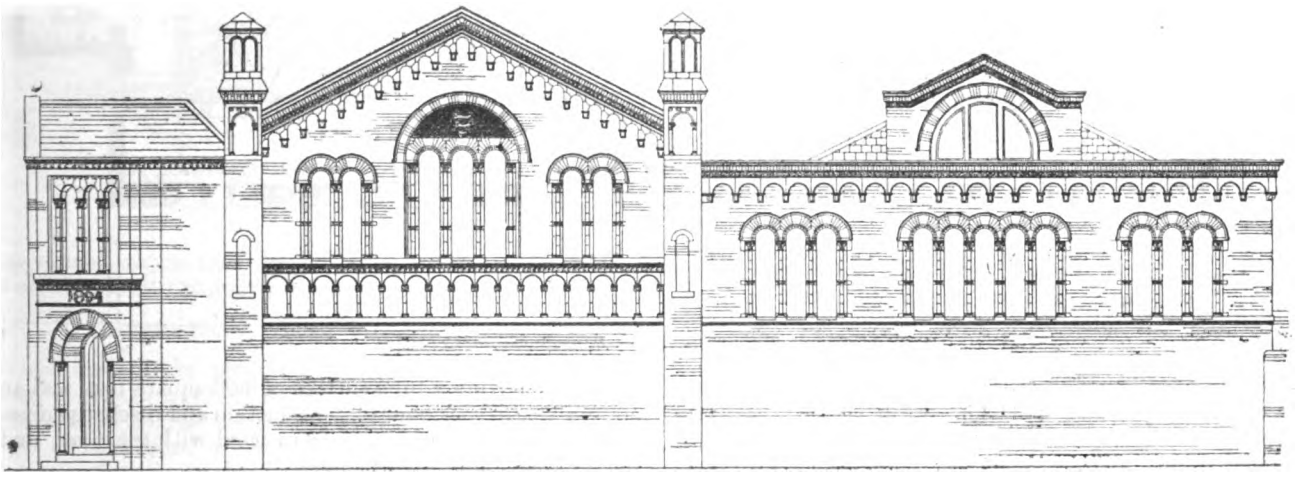
As far as the system adopted is concerned, it comprises high-pressure alternating-current generators with transformer stations for incandescent lighting, and direct-current series machines for street illumination by means of arc lamps. As will be seen from the map, the town is of a straggling character, with a portion of the borough on each side of the river.

Naturally enough, with the provisional order covering the whole borough as the authorised area of supply, and with the decision of the Corporation to erect the station outside the town where water for condensing purposes could be easily obtained, and the cost of cartage of coal saved, there was no alternative than to adopt the alternating-current system. In fact, although the compulsory area only includes the west side of the Market-place, King-street from Market-place to Row 131, Regent-street, Market-row, Broad-row, and Hall Quay, the system laid down is, taking everything into consideration, the best adapted to the requirements of the town. But it will be observed from the dots on the map, which represent the positions of the arc lamps, that the Corporation have already commenced street-lighting outside the compulsory area.

It was originally intended to start the supply to private consumers in September last, but in consequence of some delays the opening of the station is only now about to take place. The arc lighting, it may be mentioned, was commenced in August. The site chosen for the station is Corporation land in the South Denes-road, about 1½ miles from the Hall Quay, or centre of the town. Here supplies of coal are readily obtainable, whilst water

Yarmouth.—North Elevation of Station

North Elevation



Yarmouth.—West Elevation of Station.

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for condensing purposes is obtained from the river adjoining.

The names of the present members of the Electric Lighting Committee are given below, the Mayor being Mr. F. Arnold.

ELECTRIC LIGHTING COMMITTEE.

MR. RICHARD MARTINS (CHAIRMAN), DEPUTY MAYOR.

MR. J. H. BLY.	MR. J. H. PALMER.
MR. F. BURTON.	MR. W. H. PALMER.
MR. W. H. CROME.	MR. F. DANBY PALMER.
MR. E. A. DURRANT.	MR. B. HOWARD PRESS.
MR. T. GOATE.	MR. T. SAUL.
MR. E. J. HART.	MR. A. STANLEY.
MR. J. W. BUDDS JOHNSON.	MR NORFORD SUFFLING.
MR. R. NUDD.	MR. E. WINTON.
MR. J. RUNNIFF NUTMAN.	MR. E. W. WORLLEDGE.

An idea of the general arrangement of the station, which is capable of being considerably extended, will be gathered from the plan and cross-section, whilst the buildings are shown in elevation.

The Boiler-House.

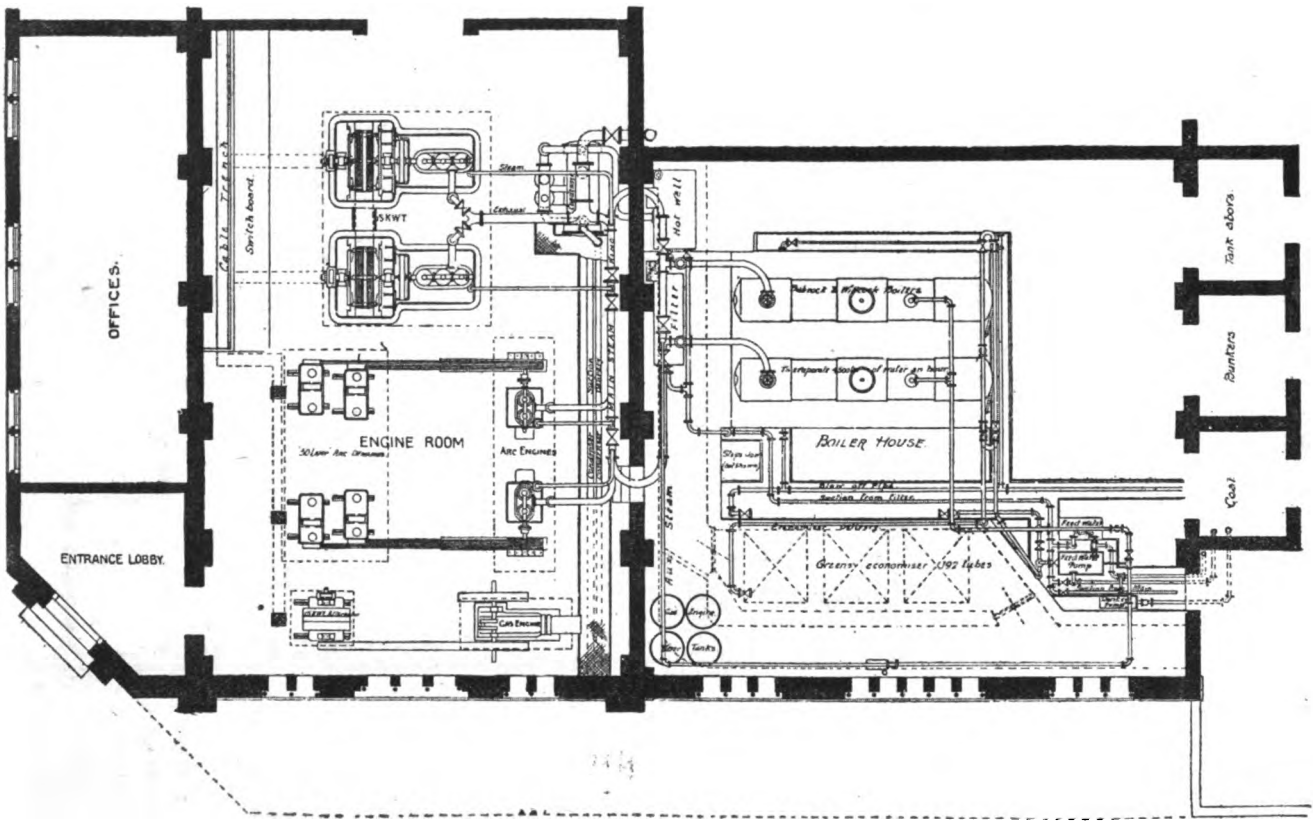
The boiler-house, which is arranged 4ft. 6in. below the level of the engine and dynamo room, contains two water-tube boilers of the Babcock and Wilcox type, constructed for a working pressure of 150lb. Each boiler is capable, with the feed water at 60deg. F., of evaporating 4,500lb. of water per hour. These boilers are provided with a feed-water ring main 3in. in diameter, and with a duplicate feed to each boiler, so that the pumps can supply either one or both boilers, and the security of the feed is effected.

There are two feed pumps of the Worthington duplex type, each capable of delivering 2,500 gallons of water per hour, and made by the Worthington Pumping Engine Company, of Queen Victoria-street, E.C. Outside the station are arranged two water-tanks having a total capacity of 9,000 gallons. These tanks are filled from the town mains by means of a donkey pump made by Messrs. W. H. Bailey and Co., of Salford, and the water is drawn from them by the pumps.

The general plan clearly shows the arrangement of the steam and exhaust pipes. It will be seen that the ring system, which has met with considerable favour in central-station work, has been introduced, together with an auxiliary steam ring main for use when necessary. The boilers deliver from their connecting pipes into the main steam ring, which is carried through the wall of the boiler-house into the engine-room, and from there the branch pipes are taken off to the engines. The ring main is of wrought iron 6in. in diameter, and the bends and branches to the engines are of copper. It will be noticed that the arrangement of the main steaming and auxiliary steam main, together with the valves, is such that the contingency of a breakdown of one boiler or a portion of the ring main would only disable that particular boiler and one engine. Separate pipes are taken to the condenser and for the operation of the pumps. Suitable arrangements are provided for draining the sections of the steam main and the engines.

The main exhaust-pipe, which is of cast iron, is 12in. in diameter, and is normally connected direct to the condenser. When the latter is not at work the exhaust steam is allowed to pass into the atmosphere through a 10in. pipe, as indicated on the plan. When, however, the condenser is in operation the valves between the exhaust-main and the exhaust-pipe to atmosphere are closed, and the condensed steam from the engines and condenser passes into the hot-well, as shown.

The condensing plant, which has been made by Messrs. W. H. Allen and Co., of Bedford, comprises a surface condenser having a tube surface of 600 square feet, and an air and circulating pump. The suction and discharge pipes of the circulating pump are connected with the river, and the air-pump with the condenser.



Yarmouth.—Plan Showing the General Arrangement of the Station.

To remove the oil gathered in the engines, the water from the hot-well is passed into a filter, from which it is drawn by either of the pumps, or, if necessary, the filter can be disconnected. The water is then either pumped into the boilers direct or is forced through the tubes of an economiser, supplied by Messrs. E. Green and Son, Limited, of 2, Exchange-street, Manchester, and thence passed into the feed-water ring main. This economiser consists of 192 tubes arranged in two groups fitted with expansion elbows, and provided with space between the pipes and the wall, thus facilitating examination, and giving access to all parts. The machine is constructed from new patterns to withstand the boiler pressure of 150lb. per square inch, all portions subjected to internal pressure being considerably strengthened.

Day-Load Plant.

As in the case of Bristol and Bedford, and as is now being specified for other towns, so also at Yarmouth has a gas-engine alternator been erected for dealing economically

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with the demand for light on the part of private consumers during the day and late at night, when the lighting requirements do not necessitate the continued working of the large machines. In this case the method of driving is by means of belt.

The gas-engine is of the Crossley type, capable of indicating 33 h.p., running at 200 revolutions, and driving, by means of a belt, a 15-kilowatt Crompton-Brunton alternator direct coupled to its exciter. The engine is fitted with heavy flywheels and special governor so as to ensure steady driving, and the alternator gives 7·5 amperes at 2,100 volts.

Arc Lighting Plant.

As will be seen from the plan showing the general arrangement of the plant, there are two sets of arc light machinery. Each set comprises an engine driving two dynamos set back-to-back, an arrangement which appears to have been more used on the Continent than in this country.

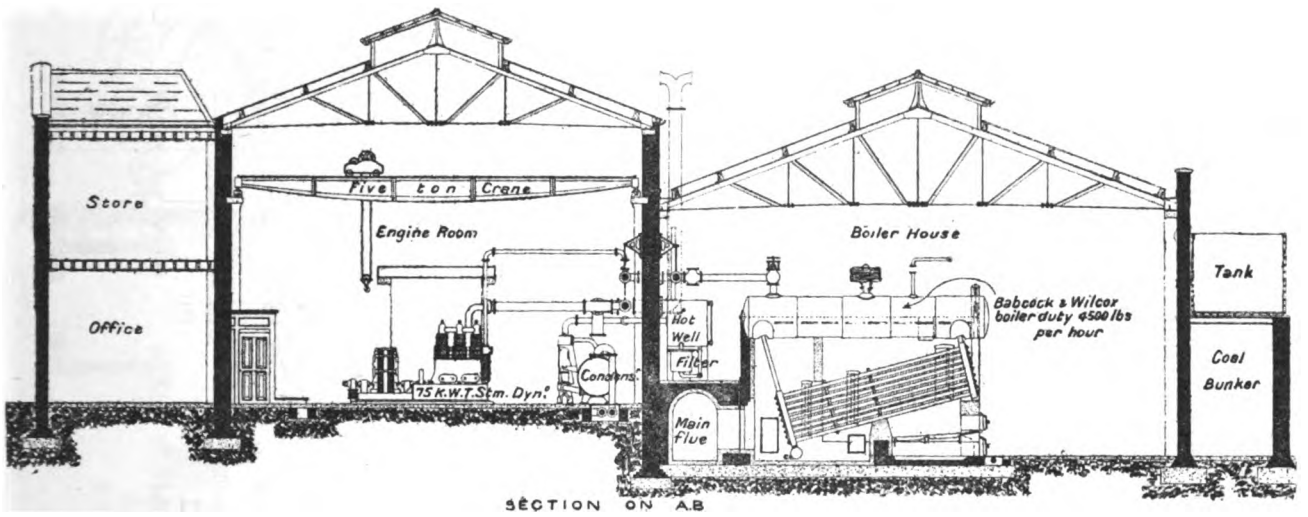
These engines are of the Willans F F compound type, arranged with independent outer plummer-boxes and pulleys for driving the arc light dynamos by means of ropes. The diameter of the high-pressure cylinder is 8½in. and of the low-pressure cylinder 12in., the stroke being 6in. Each engine has two cranks, with a low-pressure and high-pressure cylinder placed tandem fashion over each crank. The engines, which run at 450 revolutions a minute, each actuate two arc machines, the speed of which is 830 revolutions. These dynamos are of the Crompton type, being provided for this purpose. The two exciters, which, as already mentioned, are direct coupled to an extension of the armature shaft, each yield 24 amperes at 65 volts.

The engine and dynamo room is equipped with a five-ton overhead travelling crane, made by Messrs. Isles, Limited, of Stanningley, near Leeds. It is of the company's ordinary type, and is capable of lifting loads of five tons. The cross girders are of rolled steel, and the span is 35ft. The end carriages are made of wrought iron, with flanged tram wheels. The crane has motions for hoisting and lowering, two speeds, and for travelling longitudinally and transversely. All the motions are worked from the floor by endless ropes passing over grooved pulleys, and a brake and pawl are attached to the crane.

The switchboard, which is arranged on one side of the engine and dynamo room, is built up of slate panels, and of Messrs. Crompton's usual type. A separate panel is provided for each alternator, each feeder circuit, and each exciter circuit, and one is arranged for the synchroniser and pilot-wire voltmeters. Spare panels are available for additional machines. The usual arrangements for the arc light circuits have been adopted.

The Feeder and Distributing Mains.

The work of supplying and laying the mains, boxes, and connections was entrusted to the British Insulated Wire Company, Limited, of Prescot. We are able to give cross-sections of the high-pressure feeders and arc light cables.



Yarmouth.—Cross-section Through the Station.

series wound, and as each gives 10 amperes at 1,590 volts, it is capable of energising 30 2,000 c.p. lamps.

Incandescent Lighting Plant.

In the case of the plant for incandescent lighting, the method of direct driving has been adopted for the triple combination of engine, alternator, and exciter, as indicated on the general plan of engines and alternators and in elevation. There are two such combinations, and the periodicity of the alternators, which are, of course, arranged for parallel working, is 83·5 per second.

The engines are of the Willans G G G S compound type, arranged upon special bases. Each engine is bolted directly up to the bedplate of a Crompton-Brunton alternator, to the spindle of which it is rigidly coupled. The speed of each engine is 460 revolutions per minute, and each is capable of developing from 130 to 140 effective horse-power. The stroke is 6in., and the diameter of the high-pressure cylinder is 10in. and of the low-pressure 14in. Each engine has three cranks at 120deg., and as each crank has a complete compound engine driving it, the turning moment is very even, being the same on each crank at any load. This is a matter of considerable importance in running alternators in parallel.

The Crompton-Brunton alternators, each of which gives 36 amperes at 2,100 volts, have revolving disc armatures, the coils of which can readily be replaced at any time that occasion may arise. The lubricating arrangements are very efficient, a small pump driven by belt from the shaft

Paper-insulated and lead-covered cables are used throughout, the mains being armoured with steel strip, and laid direct in the ground.

The section marked A is a high-pressure cable $^{6}/_{9}$'s in the core, with a pilot wire in the centre and one on the outers of cables; B is a $^{19}/_{18}$ double concentric high-pressure cable; and C is a section of the arc light $^{7}/_{16}$ high-pressure single cable, of which nearly ten miles have been supplied. All these cables were tested to 10,000 volts before being sent from the works, and were tested to 4,000 volts at Yarmouth last week.

The low-pressure distributing mains are twin armoured cables, ·1in. square section, and each house-box is made to serve two consumers. These mains were subjected to a pressure of 5,000 volts when connected.

At present there are two arc light circuits taken from the station to the arc lamps in the town. In addition to this, an alternating circuit is provided for energising some alternating-current arc lamps.

There are two feeder mains for the incandescent lighting, which are taken to four transformer-chambers built under the pavement. Two of these sub-stations each contain a Crompton transformer of 25 kilowatts capacity, space being available for the accommodation of an additional converter of the same output. In each of the other two sub-stations is arranged a 15-kilowatt transformer of the same type, there being spare room also in this case. The reduction is from 2,000 volts to 102 volts, at which pressure the electrical energy is supplied to consumers.

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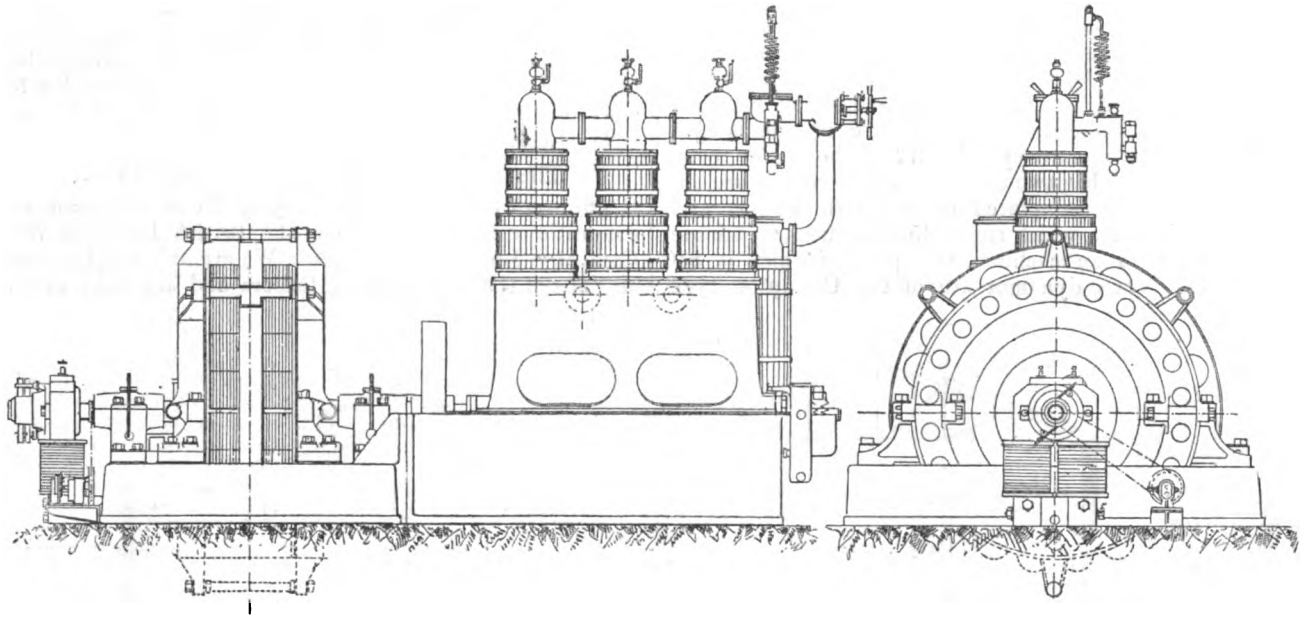
Public and Private Lighting.

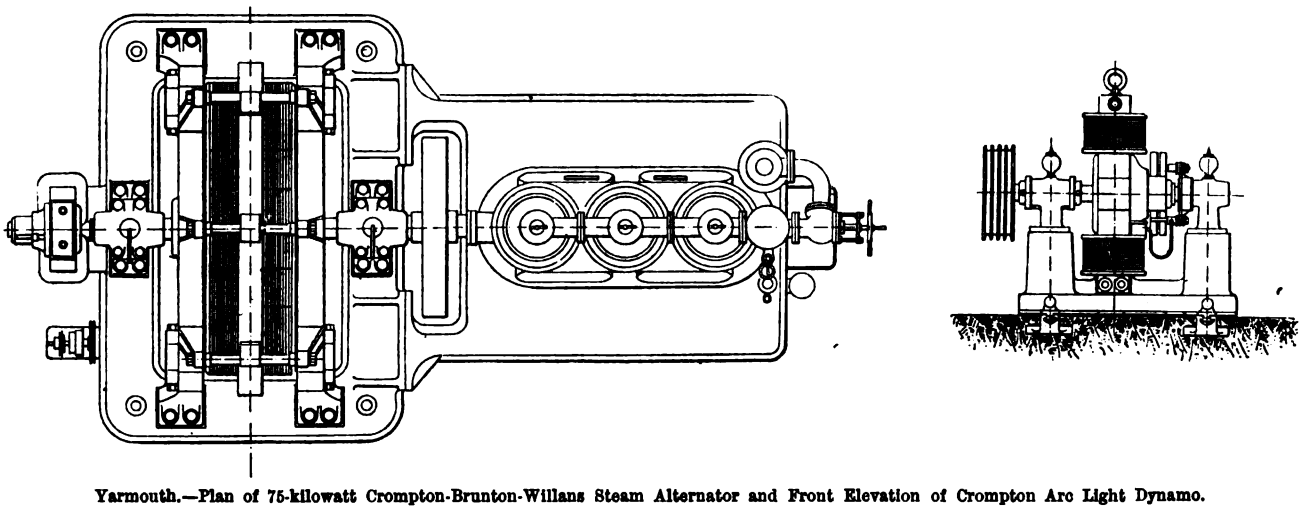
As far as the public lighting is concerned, the Corporation may be said to have been liberal in the adoption of arc lamps, there being no less than 50 10-ampere direct and 10 15-ampere alternating current lamps. The lamps, which are of the Crompton-Pochin type, are arranged on cast-iron standards, the centre of the lamp being 22ft. from the ground. The arc lamp standards were furnished by Messrs. W. MacFarlane and Co., of Saracen Foundry, Possilpark, Glasgow. In the case of the alternating-current arcs, a transformer, not placed in the base of the post, but in a concrete chamber near it, is provided for reducing the 2,000 volts to 50 volts. By means of a switch in the base of the lamp standard any one or more direct-current arc lamps can be switched out of circuit without interfering with any of the others.

The total capacity of the station for incandescent lighting is 5,000 8-c.p. lamps installed, or 3,000 simultaneously alight. Already some 1,500 lamps have been applied for, whilst including the lighting of the Municipal Buildings and the Fish Wharf, this number is increased to 2,500 lamps. Apart from this, further applications for a supply are constantly being received, so that it is probable that the output of the generating station will before long all be taken up. A supply of electrical energy is already available in Admiralty-road, Queen's-road, part of Nelson-road South, Albert-square, Marine-parade, Regent-road, King-street, Market-place, Market-row, Broad-row, Hall Quay, Regent-street, part of Alma-road, and part of Blackfriars-road and Camden-road.

The Corporation undertake to lay the supply wires to terminals immediately within the consumers' premises. No charge is made if the distance from the mains does not exceed 60ft., and provided, where it is necessary to fix a transformer, that it is not essential or desirable to build a transformer-chamber. If it is required to build a chamber of brick, it will be constructed by the Corporation, at a cost not exceeding £3, payable by the consumer. The installations are to be wired and maintained at the consumers' expense, and before electrical energy can be supplied the Corporation will test and approve of every installation. Should any defect be subsequently discovered, the Corporation may discontinue the supply until the defect is remedied to its satisfaction. Consumers are to give the officers of the Corporation access to their premises for the purpose of inspection or reading the meter at all reasonable times.

Yarmouth.—Front and End Elevations of 75-kilowatt Crompton-Brunton-Willans Steam Alternator.





Yarmouth.—Plan of 75-kilowatt Crompton-Brunton-Willans Steam Alternator and Front Elevation of Crompton Arc Light Dynamo.

The meters will be fixed on consumers' premises in a convenient position. The meter, if the property of the Corporation, will be let on hire at the following quarterly rent charge: up to 50 lamps of 8 c.p., 2s. 6d.; above 50 lamps, for every additional 50 lamps or additional part of 50, 2s. 6d. No additional lights or wires are to be used until they have been tested and approved by the Corporation. In all cases where arc lamps, motors, or other apparatus are intended to be used, special arrangements must be made.

Conclusion.

Judging from the tangible form which the electric lighting undertaking has now assumed, the Corporation have now no cause to regret the consideration of the subject of introducing a municipal supply for so many years, although seeing that the supply of gas is in the hands of two companies, we should have thought the scheme would have been completed ere this. Nevertheless, now that the

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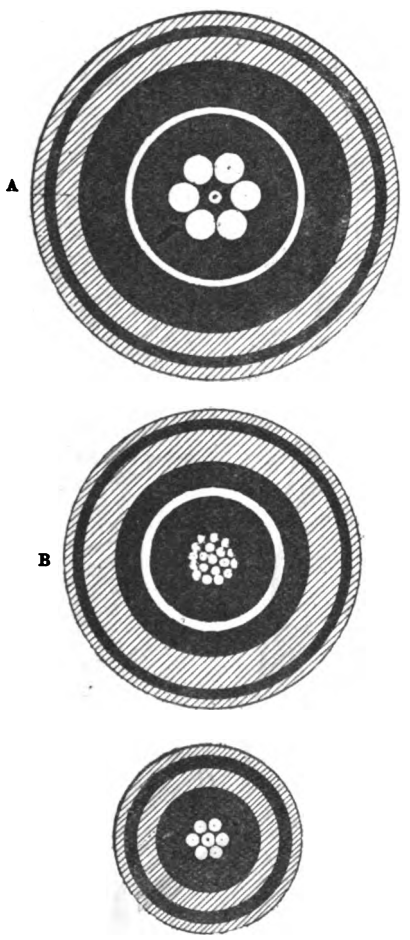
station is on the eve of inauguration, congratulations should be extended to the Corporation for having brought the electric light scheme to its present position, and to Messrs. Crompton and Co. for having so ably carried out the whole of the contract.

Gas is sold in that portion of the town now electrically lighted at the rate of 3s. 2d. per thousand, and in the other part of the borough on the other side of the river at 5s. 2d. per thousand. Even in the former case, with the judicious use of switches the electric light should compete strongly with gas, whilst in the latter, gas must largely give way to the electric light. Fancy paying 5s. 2d. per thousand for gas when one can obtain a more economical, a more healthy, and a better light for less money when supplied, as the Corporation intend to do in that district, at 6d. per unit. Extensions in that part of the borough, as subsequently referred to, are proposed on a fairly large scale, and we have no doubt as to the ultimate result.



Yarmouth—A. Section of High-Pressure Double-Concentric Lead-Covered Armoured Cable with Paper Insulation. B. Section of High-Pres ure Double-Concentric $^{19}/_{18}$'s Armoured Cable. C. Section of $^{7}/_{16}$ Single High-Pressure Cable.

In wishing success to the Yarmouth station, we must tender our thanks to Mr. W. H. Preece and his son (Mr. A. H. Preece), the consulting engineer, who are responsible for the electrical portion of the undertaking; to Mr. J. W. Cockrill, the borough surveyor, who designed the buildings; to Mr. A. W. Ranken, the clerk of works for the plant, and who will probably remain as the municipal electrical engineer; to Mr. H. H. Reynolds, A.I.E.E., representing Messrs. Crompton and Co.; and to Mr. H. Arkell, the representative of the British Insulated Wire Company, Limited, of Prescot. Mr. S. Lee Vincent, it may be mentioned, was clerk of works for the buildings.

RULES FOR INSTALLATION WORK AT YARMOUTH.

The Corporation, for the guidance and information of consumers proposing to have their premises fitted for the electric light, have issued the following rules. The Corporation do not take any responsibility with respect to any installations, and they impress on intending consumers the importance of having the work carried out by competent contractors.

Service.—The Corporation will, at their own cost, lay the necessary service lines, provided the distance from the main does not exceed 60ft.; the cost of any further length of service line must be borne by the consumer. The main fuse will be supplied by the Corporation; it will be placed in position by them and sealed. Under no circumstances must the consumer or his contractor in any way interfere with the main fuse, which remains the property of the Corporation. A main double-pole switch of an approved type must be supplied and fixed by the consumer between the meter and the main fuse. The Corporation reserve the right to settle the position of the transformer (if any), meter, main fuse, and main switch.

Meter.—The Corporation will supply and fix a suitable meter at the following rental per quarter: 2s. 6d. for every 50 8-c.p. lamps or fraction thereof. The meter to remain the property of the Corporation.

General Rules.—The whole of the work in the installation must be of the highest class, and carried out in accordance with the rules of the fire insurance company in whose office the building is insured, or, if not insured, in accordance with the rules of the Institution of Electrical Engineers.

Conductors.—All conductors to be of pure copper, according to Matthiessen's standard of pure copper, and of such sectional area that the current in them shall not exceed 1,000 amperes per square inch, their area to be so proportioned to their length that the fall of pressure between the supply terminals and the farthest lamp shall not, at full load, exceed two volts. All conductors of larger sectional area than No. 14 S.W.G. should be stranded. No conductor to be used of less sectional area than No. 18 S.W.G., except in the case of flexible cords, which may be equal in section to No. 20 S.W.G. All copper wire must be tinned.

Insulation.—All conductors to be highly insulated and mechanically protected by means of tape and braid. Flexible cords to have a waterproof insulation. The insulation resistance of the conductors to be not less than 600 megohms per mile.

Casings.—All conductors to be placed in hard wood casings, except under special circumstances, and with the approval of the electrical engineer to the Corporation, the casing to be coated both inside and out with varnish or other waterproof composition when placed in damp situations. The covers of all wood casings to be screwed and not nailed down. Metal staples must under no circumstances be used for fixing conductors. In special cases, however, metal saddles may be employed, subject to approval.

Fittings.—All fittings and electroliers must be insulated at the base. Fittings must not be wired with flexible cord. The wiring of gas fittings is expressly prohibited, unless they are efficiently insulated from the gas-pipes and duly approved.

Switches.—All switches, fuses, etc., to be of fireproof construction, and to have incombustible bases. All switches to have substantial rubbing surfaces, and to have "quick-break" action. No switch to control at one time more than 20 8-c.p. or 10 16-c.p. lamps, or one high candle-power lamp.

Fuses.—All branch circuits to be protected by two single-pole fuses. A single-pole fuse to be fixed at the origin of every flexible cord. All fuses to be of an approved type and easily accessible. Magnetic cut-outs are not to be used in any case, unless previously approved by the electrical engineer.

Voltage.—The pressure will be 100 volts at the consumer's terminals, and the lamps installed must be of corresponding voltage.

Arc Lamps.—When it is intended to use arc lamps, the electrical engineer must first be consulted in the matter, and the type of lamp, choking coil, etc., must be subject to his approval.

Testing.—The Corporation will not supply current to any installation (1) if there are any temporary wires or fittings; (2) if the whole of the work is not complete and all fittings fixed; (3) if when testing with the full pressure of 100 volts, the insulation resistance should be below the follcwing standard—viz., 75 megohms divided by the number of lamps. Should the installation prove defective when tested by the engineer to the Corporation, a fee of 10s. 6d. must be paid before the second and before every subsequent test is made.

Alterations and Additions.—No alterations must be made, or any additional lamps installed, until a notice of seven days in writing has been given to the Corporation. Failure of such notice may render it necessary for the entire supply to be cut off.

Leakage.—In the event of the insulation resistance of an installation falling below 5,000 ohms, after a supply has been turned on, the whole of the installation will be cut off until the fault has been put right. Any expenses the Corporation are put to in finding such fault must be repaid by the consumer. The Corporation reserve the right to test any installation from time to time.

PROPOSED EXTENSIONS AT YARMOUTH.

The central electric light station at Yarmouth only deals with that portion of the borough situated on one side of the River Yare, but as representations were made of defective street-lighting in St. Andrew's Ward, on the other bank of the river, Mr. J. W. Cockrill, A.R.I.B.A., A.M.I.C.E., the borough surveyor, was requested some time ago to draw up a report on the subject of introducing the electric light in that district. This report, of which an abstract is given below, was brought before the Electric Lighting Committee last week, but its consideration was deferred for six months.

The ward is now lighted by 205 gas lamps, consuming five cube

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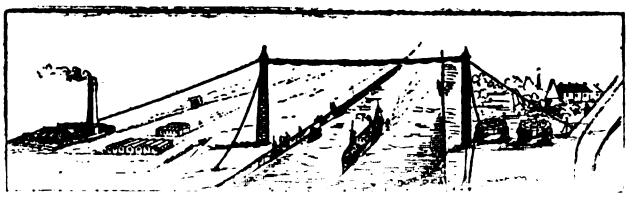
feet per hour, and one lamp of larger power consuming 15 cube feet per hour. The cost last year was £825. 12s. 8d., at the rate of £4. 1s. 3d. per lamp per annum for the 203 lamps then fixed. Each lamp is estimated to have a lighting power equal to 16 candles, a standard at which it is believed they are maintained. The cost of the paraffin lamps, including renewals, repairs, lighting, cleaning, etc., has been about £2. 15s. per annum per lamp; their lighting capacity is equal to the gas lamps, and very few complaints have reached the surveyor about them during the eight years they have been in use.

To light the whole district with arc lamps would involve fixing about 120 lamps, at a cost of £1,200 per annum in excess of the present gas bill. The estimates have therefore been based on lighting with 34 arc lamps the Southtown-road and High-street from the foot of the bridge to the Gorleston tramway terminus, Feathers' plain, and to light the remainder of the district with 25-c.p. incandescent lamps at the points now lighted with gas. This would cost about £300 per annum in excess of the sum now paid for gas after making allowances for paying the proper proportion of interest and sinking fund chargeable to this part of the installation. The sub-committee charged with inspecting the electric light installations in other towns some time since reported adversely as to street-lighting by incandescent lamps, and in several towns where they were tried for lighting the public streets they have been given up. At Chelmsford, where the sub-committee saw them in use, they are still running and giving every satisfaction, and in several small towns in Belgium and Germany, which the surveyor has recently seen, they are at work very satisfactorily. The capital expenditure involved in carrying out this scheme is as follows:

Additions to buildings	£500
Boiler, engines, and dynamos	2,500
Crossing river	600
Street mains and transformers	6,400
Arc lamps and posts, and incandescent lamp-posts and brackets	1,000
	£11,000

The above estimate provides for putting in plant and mains for installing about 3,000 private lights, a number which the surveyor thinks would be readily taken up, as the cost of electricity at 6d. per unit is less than the price of gas on that side of the water. The revenue derived from this amount of private lighting would be about £1,500 per annum, upon which, of course, some profit would be made. The question of crossing the river has had considerable attention, and Mr. Cockrill has designed several methods of carrying the cables under water, but the cost of any method will be quite £500 more than the estimate previously given. The scheme shown on his drawings, and allowed for in the estimates, is much simpler, more readily accessible, and much less liable to accidents than any method of carrying the cables under the river bed.



Yarmouth.—Suggested Arrangements for Carrying Cables Over the River.

The height at which the surveyor proposes to cross the river is 160ft. above the highest part of the quay, which, after making allowance for the "sag," should leave 155ft. at least clear headway between the cables and high-water mark. The masts would be light-looking wrought-iron lattices, only occupying ground the size of an equilateral triangle of 15ft. side, stayed back on the east side to the site of the electric light station, and on the west side to the triangular piece of ground on the south of the Southtown gasworks; all stays cross the roads at considerable height and would be no obstruction. The cables which it will be necessary to cross the river with are four arc lighting cables, two high-pressure cables for street-lighting by incandescent lamps, and two high-pressure mains for private lighting, and as these must be in duplicate, there will thus be 16 mains to be supported. A rope would be provided for running a car by which the cables could be constantly under inspection and always accessible for repairs. The sketch shows the class of structure which would be needed. The scattered nature of the district is the cause of the expense being so great, the public and private lighting together requiring nearly 35 miles of mains.

SUBMARINE CABLE GRAPNELS.

Two new forms of cable grapnels have been brought out by Messrs. Johnson and Phillips, of London and Charlton, who make a speciality of all kinds of apparatus for the laying and repair of submarine cables. These grapnels, which have been devised by Mr. Claude Johnson, are illustrated herewith. In Fig. 1 is shown a sectional elevation of his collapsible prong grapnel for the recovery of cables lying on rocky bottoms, whilst in Fig. 2 its outward appearance is represented. Any one, or all, the prongs can retire within the shield either before or after the cable is hooked, and no formation of rocks which could possibly stop the progress of the dragging, or injure the instrument, can be imagined.

The principle of the automatic movement of the prongs of this grapnel are essentially different to a grapnel having retractile prongs. In the latter form the prongs open outwardly, thus practically increasing the size of the instrument, and the expanded prongs are in their weakest position to resist strain from contact with rocks. It will be observed that in Mr. Johnson's device the reverse action takes place, and the prongs cannot be injured.

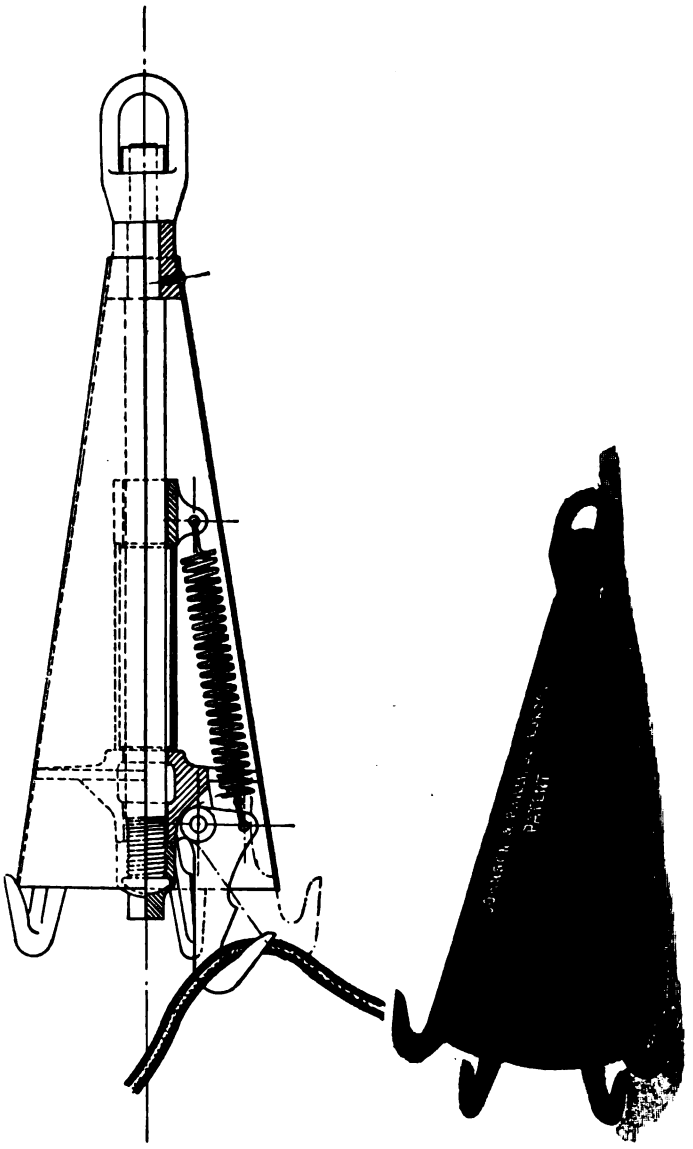


Fig. 1. Fig. 2.

The second form of grapnel is intended for the recovery of cables in mud bottoms. This grapnel has two steel prongs, which are comparatively thin but deep in section, so as to offer little resistance to their penetration into the mud. The prongs are connected to one end of a broad flat plate which constitutes the shank, the plane of which is at right angles to the plane of the prongs. On dragging with this grapnel the shank slides with its flat face on the surface of the mud, whilst the downward-directed prong penetrates to its full length into the mud so as to seize the cable embedded therein. Those engineers who are engaged in the repair of submarine cables are well aware of the utility of grapnels which will drag rocky bottoms without injury to the prongs, and also of the value of reliable grapnels for the recovery of cables from muddy bottoms, and for these reasons the two new forms of grapnels described above will be highly appreciated.

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NEW DESIGN OF CONTINUOUS-CURRENT DYNAMO.

Two or three weeks ago we recorded the opening of the new electrical engineering works of Messrs. Thomas Parker, Limited, of Wolverhampton, and we are now enabled to give illustrations of the company's new design of continuous-current dynamo.

As will be seen from Fig. 1, one of the novel and special features of this dynamo is the fact that the pole-pieces are cut through and hinged, so that they can be turned back to allow of examination or taking out of the armature by a direct vertical lift, and without unsetting the bearings. The hinge is placed at the angle of the pole-piece, so that when turned back halfway the magnet ferrule can be lifted off (after the armature has been removed) without uncoupling the hinged piece. This arrangement allows of machines being fixed in confined spaces, which would not be suitable with the ordinary type of machine, where the armature has to be threaded in to or out of the magnets. There is also considerably less risk of damage in withdrawing or replacing the armature. The arrangement of the machine with the pole-pieces closed is shown in Fig. 2.

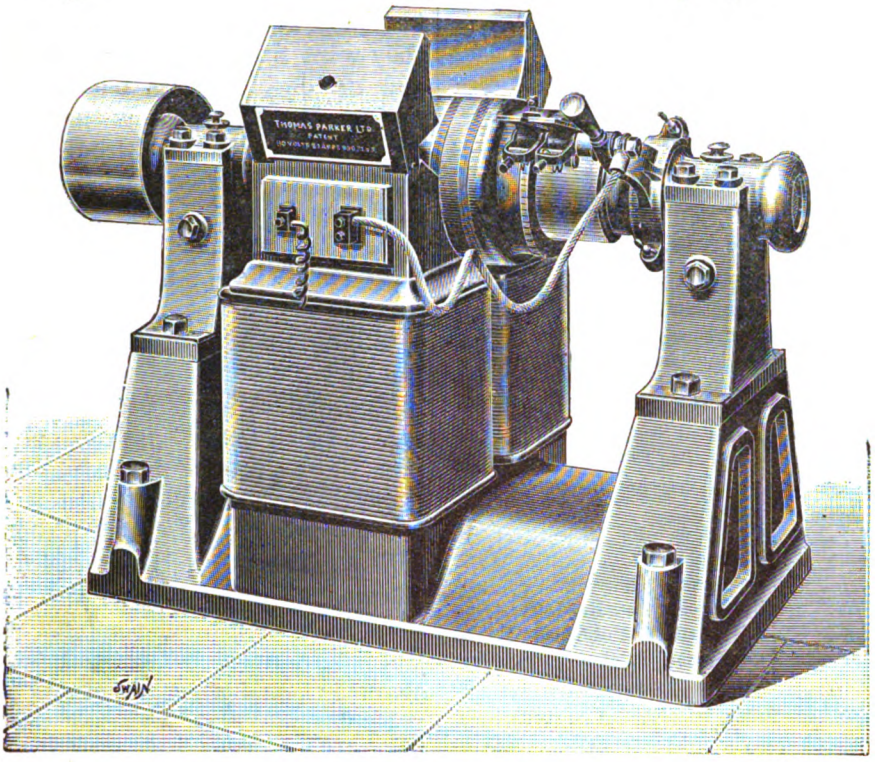

FIG. 1.—Parker's New Continuous-Current Dynamo, the Poles being shown turned back.

An oil-well is provided in the pedestal underneath the bottom of the bearing (the bottom bearing being continuous); a ring runs in this well and over the top of the shaft, giving continuous lubrication. Where machines are coupled direct to high-speed engines the armatures are arranged at the bottom, the pole-pieces in this case also being cut through, so that the upper portion of the magnets can be lifted away and the armature then lifted out. The armatures of these machines are coil wound under the Eickemeyer patents, and by means of these new arrangements the putting in or taking out of an armature is rendered not only much more simple, but it also occupies far less time than is required by the old method.

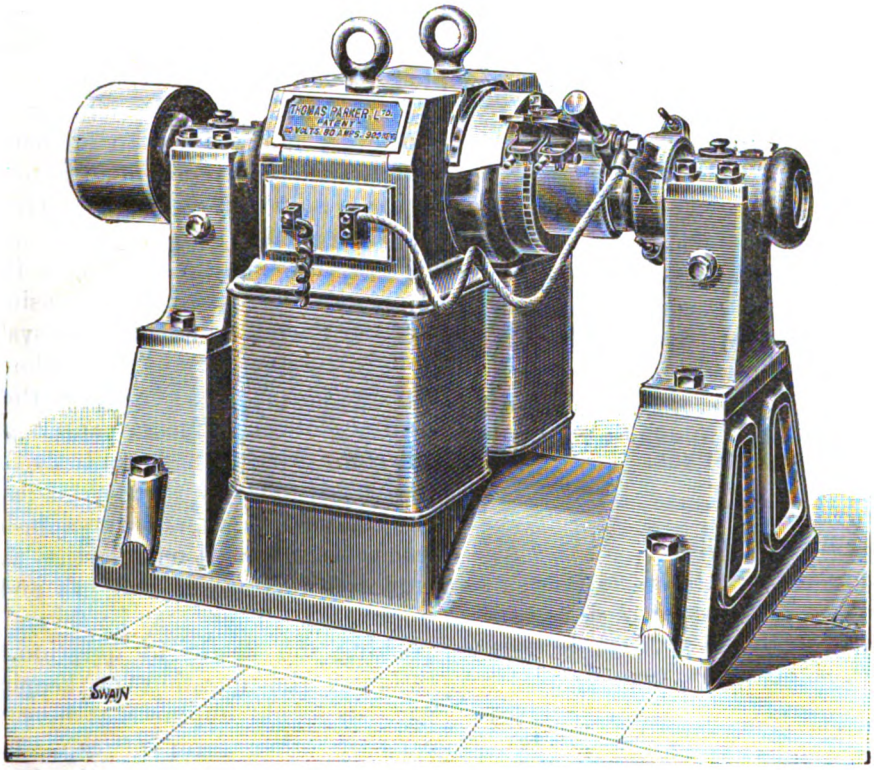

FIG 2.—View of Parker's Continuous-Current Dynamo, with the Pole-pieces closed.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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EXPLOSIONS.

A lot of rubbish has been printed recently in the daily papers anent the so-called dangers of underground electric light wires and cables, and no doubt more twaddle of a similar kind will follow from time to time. It was just the same with gas-mains when they were first laid down. But that is long ago, and no one, at least outside the electrical and engineering Press, now says anything of the hidden peril resulting from the presence of gas existing everywhere below the surface. Of the great risks due to its use in dwelling-houses and other places, ample proof is afforded week by week. It was, we believe, Sir Frederick Bramwell who recently stated that the subsoil of the Metropolis is saturated with coal gas escaping from leaky mains, and that it was scarcely possible to make a hole in the ground at any spot without encountering this gas. It does not like its rival, electricity, and manifests its displeasure by exhibiting a great affinity towards it. The affection, it is needless to say, is not of a mutual kind, and although electricity has kept as far as possible to itself, yet coal gas has followed up its embraces, with the result of explosions in underground conduits and junction-boxes. But there must be an end to incidents of this character—and what is that end to be?

Explosions have occurred recently in junction-boxes in the City where the presence of coal gas has been found, and where lead-covered concentric cables laid in iron pipes are used. They have also taken place in St. Pancras, where bare copper mains are laid down, an enquiry into the latest of these having been held yesterday, and which is referred to in another column. Kensington, two or three years ago, was the scene of a similar explosion in connection with a culvert system; but London is not alone in this matter. Glasgow, and one or two other towns, have had a similar experience. It is, however, unnecessary to further dilate upon this point, the occurrence of most of these explosions being of so recent date as to be fresh in the minds of our readers.

Now, the question arises, is it not possible to overcome this apparently increasing difficulty in connection with the underground systems of mains of supply companies and local authorities? We think so; but how? Gas permeates the subsoil, and our central-station engineers cannot get rid of it from the soil. That being admittedly the case, the alternative is either to prevent the leakage of gas into the conduits, pipes, and junction-boxes, or to ventilate these in such a manner that the formation of an explosive mixture of coal gas and air is rendered impossible. There may be several means of accomplishing the desire in question. Take first, for instance, the question of keeping out the coal gas. It would appear that by placing a clamping cap, or other form of cap, over the ends of spare pipes entering junction-boxes, and airtight caps over the ends of cable-carrying pipes entering the boxes, suitable provision being made for the admission of the cables, the difficulty would be overcome, especially with the use of ventilating pipes arranged at certain intervals. But even if the walls

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of the junction-boxes are bricked and cemented and then covered with some impermeable composition, the contingency of gas entering and getting mixed with air so as to form an explosive mixture, will always be present. The method, in fact, does not seem to possess the great desideratum of absolute immunity. Another method of preventing the admission of gas—namely, the use of oil-insulated mains and distributors—may be mentioned. This system has now been in use in this country for some years, and there is, we believe, not a single case on record where an explosion has occurred in towns where this type of main has been put down.

As to permitting coal gas to play at its own sweet will, there is reason to assume that this can be allowed with proper care. It is purely a matter of ventilation. Not, however, in the sense of the doubtful expedient of erecting pipes alongside buildings to carry away coal gas, but in the direction of ensuring an efficient ventilation of the conduits and pipes. This can be accomplished by forcing through the conduits and pipes, by means of a blower, air which has previously been dried by being passed through a drying mixture. This system has, if we remember rightly, been adopted with considerable success at Newcastle and Cambridge, and one or two other towns, and is about to be introduced at Bedford. In fact, the Newcastle and District Company have forced air through their system of pipes and joint-boxes for five years, and no trouble has been experienced from either gas or moisture.

In the foregoing remarks we have endeavoured to briefly indicate methods which we think will tend to minimise, if not entirely obviate, the danger of explosions; and we shall be glad to learn the experience of central-station engineers on this subject, which is assuming considerable importance at the present time. It is not a matter to be lightly treated, but one which must be seriously considered and satisfactorily solved.

BUSINESS DURING 1894.

(Continned from page 23.)

Delaware Hard Fibre Company.

The representative of this company in this country, Mr. J. Burns, of 15, Long-lane, E.C., reports that the past year has been one of continual progress, and that the company have had to acquire extended warehouse room for the larger stock needed to execute orders promptly. Their stock of sheets, rods, and tubes is now very complete, and special attention is given to the supply of washers and special shapes.

W. T. Henley's Telegraph Works Company, Limited.

This company report that their business during 1894 showed a very satisfactory increase over that of 1893, and that, contrary to their experience of previous years, they actually had no slack time whatever during 1894. This favourable position is attributed to a great extent to the efforts of the company's branches, installation work having been very stagnant in the London district for some months out of the year. The Manchester, Bradford, and Glasgow districts have apparently been the foremost as regards amount of work done, and taking into consideration the fact of the company having secured, among others, valuable contracts for Glasgow, Edinburgh, and St. Pancras, and that their general trade has been good, the company have every reason to be satisfied with the year's work.

Liverpool Electric Supply Company.

The Liverpool Electric Supply Company, Limited, have during the past 12 months largely increased the number of lamps supplied from their mains, the total supplied now being equivalent to 31,000 16-c.p. lamps. During the year numerous installations have been carried out both in connection with the company's system and by means of isolated sets of plant. Among the latter may be mentioned the lighting of Childwall Hall for Mr. H. G. Schintz, and a large installation at the Albert Dock for the Mersey Docks and Harbour Board.

Manchester Edison-Swan Company.

During the past year the Manchester Edison-Swan Company have been exceptionally busy. The principal installation they have carried out has been the central station of the Altrincham Electric Supply, Limited (for which they obtained the complete contract), which is an alternate-current station, working at 2,000 volts, and supplying current over a large district of Altrincham and Bowdon. The alternators used are of the Manchester Edison-Swan Company's make. The company have also constructed central-station apparatus for several corporations and supply companies, including the large switchboard for the Bolton Corporation. Amongst the private installations which have been carried out are those for Mr. S. Armitage, of Pendleton; Mr. F. W. Travers, of Bowdon; Mr. L. Pilkington, of Pendleton; and Mr. E. Pilkington, of Clifton; also installations on the premises of Messrs. J. L. Barker, W. O'Hanlon, W. Dykes, A. Coupe, J. Barningham, all of Bowdon; at Mr. G. W. Bonson's, Altrincham; and Mr. Thos. Townley-Townley Parker's, Preston. Amongst the shops, hotels, warehouses, etc., which have been lighted by this company may be mentioned the following: Brooke, Bond, and Co., Manchester; Technical School, Leigh; Empire Palace, Birmingham; Textile Mill Company, Oldham; Bull's Head Hotel, Birmingham; Garrick Hotel, Manchester; Marshes Restaurant, Manchester; Mr. I. Frankenburg, Salford; Manchester Coffee Tavern, Manchester; New Circus, Bolton; Mr. A. Cowsill, Altrincham; J. Moss and Sons, Manchester; W. T. Glover and Co., Salford; W. Graham and Co., Redfern and Son, Beaumont Bros., Brookfield, Aitchison, and Co., J. Wilkinson and Co., J. Woolley and Sons, and Corn Exchange, the last seven of Manchester; Axe and Cleaver Hotel, Altrincham; Swan Hotel, Bolton; Congregational Church, Bowdon; W. Thorburn, Sons, and Co., Manchester; Union Bank, Leigh; Maxwell and Tuke, Manchester, and many others.

Willans and Robinson, Limited.

We have received some information from Messrs. Willans and Robinson of their work during the year, and which shows how large a proportion of the central stations in progress are being equipped with the Willans central-valve engine, which is steadily coming into still more extended use. The following figures are very remarkable in these days of bad trade.

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Engines ordered in	1891	11,100 h.p.
,, ,,	1892	14,300 ,,
,, ,,	1893	18,950 ,,
,, ,,	1894	26,624 ,,

With the total power the size of the engines is also increasing, the orders booked including eight engines of 700 h.p. each, 13 of 360, four of 300, 12 of 200, six of 240, and two of 1,400 each (these last, though for driving dynamos, are not for electric lighting), while the average size of the whole number is 166 h.p., a result which could scarcely have been foreseen by the makers of high-speed engines a few years ago. The principal central-station orders received during 1894 were from or on account of the following: Westminster Electric Light Company, London (additions), 1,280 h.p.; City of London Lighting Company (additions), 5,600 h.p.; Kensington and Knightsbridge Company, London (additions), 360 h.p.; Liverpool Electric Light Company (additions), 600 h.p.; Norwich Electric Light Company (additions), 270 h.p.; Birmingham Electric Light Company (additions), 300 h.p.; Chelsea Electric Light Company, London (additions), 655 h.p.; Blackburn Corporation, 560 h.p.; Edinburgh Corporation, 1,750 h.p.; Sunderland Corporation, 354 h.p.; Yarmouth Corporation, 420 h.p.; Cheltenham Corporation, 360 h.p.; Brighton Corporation (additions), 600 h.p.; Glasgow Corporation (additions), 720 h.p.; Tunbridge Wells Corporation, 300 h.p.; Aberdeen Corporation (additions), 400 h.p.; Whitehaven Town and Harbour Trust (additions), 120 h.p. The largest of these orders—that for the City of London Lighting Company (through the British Thomson-Houston, Limited)—includes eight engines of 700 h.p. each, which will be coupled direct to Thomson-Houston alternators running at 300 revolutions a minute. The following private installations may be mentioned: United Alkali Company; Messrs. Albright and Wilson, Oldbury (additions); Army and Navy Stores, London. The following foreign contracts may also be noted: Liège lighting, Belgium; St. Petersburg lighting; Caen lighting, France (additions); Liège electric tramways; Dutch State Railways (additions). The above-mentioned figures amount to over 18,600 h.p., and of this about 12,450 has been ordered by those who are already users of the Willans engine. During the past year engines ordered previously have been erected and started in the following places: Birmingham Grand Hotel; Messrs. Berkenbusch and Co., Brunswick (flour mill); Messrs. Gunning and Campbell, Belfast (flax mill); Nottingham Corporation electric light station; Messrs. Albright and Wilson, Oldbury; Rotterdam electric light station; Bradford Corporation electric light station (additions); Holborn Restaurant, London; Hampstead Vestry; Biarritz lighting; St. Pancras Vestry (additions); Glasgow post office; Hove lighting (additions); Messrs. McKechnie, Widnes; London, Brighton, and South Coast Railway, Newhaven (additions); Dewsbury Corporation electric light station; Bristol Corporation electric light station (additions). The Willans engine up till recently has been made in comparatively small sizes, not exceeding 350 h.p., and its chief use has been for electric lighting, for which its high speed specially fits it; but it is now being made in larger sizes, and for many other purposes. The large order for the City Lighting Company of eight engines of 700 h.p. marks a new departure in electric light engineering in England, as it is perhaps the largest yet given for electric light engines, and certainly no attempt has been yet made to introduce high-speed engines of so large a size. So far as we know, the largest hitherto used have been Willans engines of about 350 h.p. running at 350 revolutions per minute. The electro-chemical industry is one which is fast growing into great importance, and in which the generating plant is run under conditions even more trying than those of electric lighting. Not only are high-speed engines a necessity, but they are kept constantly running under their full load for long periods at a time. Several engines ordered during the past year from Messrs. Willans and Robinson are for this purpose, as, for instance, those for Messrs. Albright and Wilson, Oldbury, which have to make runs of six weeks' duration without a stop; for Messrs. McKechnie, Widnes; and the United Alkali Company. Messrs. Albright and Wilson's order was given in consequence of the successful working of engines previously supplied, which have been running perfectly satisfactorily under the above conditions. In millwork, also, the Willans engine has proved successful, where its high speed and even turning movement enable it to give exceedingly steady driving. The two large engines at Messrs. Gunning and Campbell's flour mill at Belfast, and Messrs. Berkenbusch's flour mill at Brunswick, which were started in the course of last year, have now been running successfully for some six months. We understand that the first named—a triple-expansion engine—has recently been tested, with the result that the consumption proved to be under 12·8lb. of steam per indicated horse-power per hour, and while the steadiness of driving far surpasses any of the older slow-running engines, the periodic variation of speed per revolution not exceeding 0·2 per cent. of the speed (300 revolutions per minute), as shown by a Moscrop speed recorder. The Willans engine has been applied to electric traction, though not as yet in England. An order has been received for the engines for the electric tramways at Liège, Belgium, which will be started in the course of the present year, and the experience gained with the Willans engines on the electric tramway at Hobart, Tasmania, leaves no doubt as to their successful working. We understand, too, that other orders for traction work are pending. Some reference may also be made to two powerful engines which the company are making for the Heilmann electric locomotives now under construction in France. These engines are of 1,400 h.p. each, and run at 400 revolutions per minute; they are of very special design necessitated by the great power and high speed required, and by the small space and weight which can be allowed. The company exhibited two engines of 200 h.p. each, as well as a smaller one, at the Lyons Exhibition. The two larger engines were employed in lighting the buildings during the whole period of the exhibition, a work which they performed without hitch of any kind. For these two engines the company were awarded the *grand prix*. Another purpose for which the Willans engine is being employed is that of air-compressing. In this case the compressor is practically a Willans engine reversed, with certain small modifications which enable it to act as a pump instead of as a motor. It is coupled directly to and is driven by an ordinary central-valve engine. Several orders have been received for these air-compressors during the year, as well as for engines for lighting mines, driving mining stamps, etc. For some time the works at Thames Ditton have been considerably overtaxed, and Messrs. Willans and Robinson have had in view the erection of new works in which to deal with their larger engines. They have now purchased a site of about 25 acres at

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Rugby, in close proximity to the London and North-Western Railway, and it is their intention to start building at once.

REVIEWS.

Electrical Engineering as a Profession. By A. D. SOUTHAM. London: Southam and Co. Official edition.

We some time ago had occasion to notice in its first form Mr. Southam's guide to electrical engineering as an occupation in life, and were able to mark with approval the issue of a work dealing with the entire subject in a fashion satisfactory on the whole. The present issue appears to be an enlarged issue of the author's original handbook, though we do not quite see the object of entitling it "official," except that the particulars of technical colleges and training institutions herein given have been "officially" supplied to the author. The first part of the new edition is essentially Mr. Southam's personal contribution to or criticism of the discussion respecting a parent or guardian's proper duty towards the youthful would-be engineer: and he deals with the matter very largely upon the lines we advocated ourselves a year or two ago, when a small epistolary parliament was held in these pages in order to thoroughly ventilate the opinions of those best fitted to speak upon the subject. Mr. Southam both gives and quotes very sound advice, which may be read with advantage by all interested, not merely by parents, but by youths and students also. The remainder of the book (which has now grown to a volume of some 200 pages) comprises descriptions of the leading technical colleges and institutions, with all the necessary information as to fees, etc., and also of those electrical and engineering firms or companies who receive apprentices. We note amongst these one or two whose names can hardly be called household words, though probably Mr. Southam has sufficient reason for including them. Speaking generally, the book may be commended as the best of its kind, a number of capital illustrations helping very materially to increase its use and appearance.

Standard Methods in Physics and Electricity Criticised; and **A Test for Electric Meters Proposed.** By H. A. NABER. London: 1, 2, and 3, Salisbury-court, E.C.

This is rather a curiously-written book, the author of which has devised a somewhat novel form of gas voltameter. He states it as being his opinion that a good appliance of this kind is well adapted not only for standardising large-current galvanometers, but other instruments also, besides being capable of use in ordinary measurements, and even as an electricity meter. This position he discusses at some length in a series of chapters possessing considerable interest, not their least value being the utterly unconventional tone in which they are written.

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 10.

At last night's meeting of the Institution, the following candidates were balloted for:

Foreign Members.—Prof. André Blondel, electrician and engineer of the Ecole des Ponts et Chausseès, and of 2, Boulevard Raspail, Paris; and H. Ward Leonard, 44, Broad-street, New York.

Associates.—William John Aubert, Shepperton, Middlesex; Ernest E. Bartlett, 5, St. Frideswide-terrace, Osney, Oxford; William Church, Marlborough House, Pall-mall, S.W.; E. S. Curtis, Box 96, Johannesburg; Charles Manners Donnie, 36, Queen-street, London, E.C.; Reginald Falshaw, 17, Princes-street, Harrogate; John Raven Frankish, Town Hall, Melbourne; Julius Frith, The Owens College, Manchester; Alfred Sharman Giles, 48, James-street, Buckingham Gate, S.W.; Arthur Hattersley, Trinity Wharf, Blackwall, E.; William Jones, 2, Middleton-street, Hull; Lionel James Langridge, Royal Insurance Company, Lombard-street, London, E.C.; A. B. Layton, 4, Bellevue terrace, Charlton-road, Blackheath, S.E.; Samuel Arthur Mahood, "West Lynne," Comer-road, St. John's, Worcester; George W. Money, 36, Windermere-street, Gateshead-on-Tyne; Joseph Allison Newton, Melbourne, Australia; Alfred William Sharpe Pocklington, 6, Cressingham-road, Lewisham, S.E.; Carl W. Schaefer, the Eastern Telegraph Company; Alfred Schwartz, A.K.C., A.M.I.C.E., Ivy House, Woodford Green, Essex; Henry John Wagg, 40, Bryanston-square, W.; Arthur Thomas Walmsley, 9, Victoria-street, Westminster, S.W.

Students.—Dennis H. Bayley, Cliff Lodge, Southfields, S.W.; Frederick Simmons Grogan, 33, Criffel-avenue, Streatham Hill, S.W.; Luis Ebenor Hazera, Faraday House, Charing Cross-road, W.C.; C. McCarthy-Jones, Elm View, Woodside Park, N.; H. J. Saunders, 117, Sutherland-avenue, Maida Vale, W.; John Ortelli Zerega, Faraday House, Charing Cross-road, W.C.

The minutes of the previous meeting having been read, the retiring president, Mr. A. Siemens, presented the Salomons scholarship to Mr. E. E. Holmby.

Prof. Ayrton proposed and **Sir David Salomons** seconded a vote of thanks to the retiring president, this being unanimously carried.

Mr. R. E. Crompton, the new president, then delivered his address, stating that he would do so mainly from the mechanical point of view of an electrical engineer.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 11).

40. *Actual Leakage Factor of Machine.*—By a very simple method devised by the author the total flux, ϕ'', of magnetic circuit of a dynamo can be calculated from the running data of the completed machine, and the actual leakage factor for any particular dynamo can therefore be found for the formula,

$$\lambda = \frac{z \times \phi''}{\phi} = \frac{\phi'}{\phi} \quad . \quad . \quad . \quad . \quad (135)$$

where ϕ'' = total flux of magnetic circuit, in webers, calculated from test data;

ϕ' = total flux in entire magnet frame, in webers;

ϕ = useful flux cutting armature conductors, in webers, from formula (91) or (92) respectively;

z = number of magnetic circuits in machine.

The writer, by employing his method above referred to, has figured the actual leakage factors for nearly 200 practical dynamos, of which the complete test data were at his command; and by combining his results with the researches of Hopkinson, Lahmeyer, Corsepius, Esson, Wedding, Ives, Edser, and Puffer, has averaged the following Table LII. of leakage factors for dynamos of various types and sizes, which is to be used for obtaining an approximate value of the leakage coefficient for the preliminary calculation referred to in Chapter 36.

From this table the general rule will be noted that the factor of leakage is the greater the smaller the dynamo, which is due to the difficulty, or rather impossibility, of properly diminishing the magnetic circuit in small machines. In these, on account of the comparatively large space occupied by the armature winding, the length of the air-gaps is much larger, and the relative distances of the leakage surface much smaller in proportion than in large dynamos. The permeance of the air-gaps, therefore, is relatively much smaller, while the permeances of the leakage paths are considerably larger, comparatively, than in large machines, and formula (110) in consequence will produce a high value for the leakage coefficient for a small dynamo.

It further follows from Table LII. that the leakage factor for various types and sizes of dynamos varies within the wide range of from 1·10 to 2·00, which result agrees with observations of Mavor, who, however, seems not to have considered capacities over 100 kilowatts. By comparing the values of λ for any one capacity the relative merits of the various types considered may be deduced.

Thus it is learned that, as far as magnetic leakage is concerned, the horizontal double-magnet type (column 6) and the bipolar iron-clad type (column 7) are superior to any of the other types, which undoubtedly is due to the common feature of these types of having the cores of opposite magnetic potential in line with each other on opposite sides of the armature, thus reducing the magnetic leakage between them to a minimum.

Next in line, considering bipolar dynamos, are the inverted horseshoe type (column 2), the single-magnet type (column 4), the upright horseshoe type (column 1), and the vertical double-horseshoe type (column 8).

* From the *Electrical World* (New York).

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TABLE LII.—Leakage Factors for Various Types and Sizes of Dynamos.

CAPACITY IN KILO WATTS	FACTOR OF MAGNETIC LEAKAGE.															CAPACITY IN KILO WATTS
	1 UPRIGHT HORSESHOE TYPE	2 INVERTED HORSESHOE TYPE	3 HORIZONTAL HORSESHOE TYPE.	4 SINGLE MAGNET TYPE	5 VERTICAL DOUBLE MAGNET TYPE	6 HORIZONTAL DOUBLE MAGNET TYPE	7 BIPOLAR IRON CLAD TYPE	8 VERTICAL DOUBLE HORSESHOE TYPE	9 HORIZONTAL DOUBLE HORSESHOE TYPE	10 FOURPOLAR IRON CLAD TYPE	11 SINGLE MAGNET MULTIPOLAR TYPE	12 RADIAL MULTIPOLAR TYPE	13 INNER-POLE TYPE	14 TANGENTIAL MULTIPOLAR TYPE	15 AXIAL MULTIPOLAR TYPE	
1	2·00	1·75	.....	1·90	.....	1·50	1·50	.....	.....	.....	.....	.....	.....	.....	.....	·1
·25	1·80	1·60	.....	1·75	2·00	1·40	1·40	.....	.....	.....	.....	.....	.....	.....	.....	·25
·5	1·70	1·50	2·00	1·65	1·90	1·35	1·35	1·80	1·90	.....	.....	.....	.....	.....	.....	·5
1	1·65	1·45	1·90	1·60	1·80	1·30	1·30	1·70	1·75	.....	.....	.....	.....	.....	.....	1
2·5	1·60	1·40	1·80	1·55	1·70	1·28	1·28	1·60	1·65	1·75	1·60	1·50	1·40	1·90	2·00	2·5
5	1·55	1·35	1·75	1·50	1·65	1·25	1·25	1·55	1·60	1·65	1·50	1·40	1·35	1·80	1·99	5
7·5	1·50	1·30	1·70	1·45	1·60	1·22	1·22	1·50	1·55	1·60	1·45	1·35	1·32	1·70	1·80	7·5
10	1·45	1·28	1·65	1·40	1·55	1·20	1·20	1·45	1·50	1·55	1·40	1·32	1·30	1·65	1·70	10
25	1·40	1·25	1·60	1·35	1·50	1·18	1·18	1·40	1·45	1·50	1·35	1·30	1·28	1·60	1·65	25
50	1·35	1·23	1·55	1·32	1·45	1·15	1·15	1·35	1·40	1·45	1·30	1·28	1·25	1·55	1·60	50
100	1·30	1·20	1·50	1·30	1·40	1·12	1·12	1·30	1·35	1·40	1·25	1·25	1·22	1·50	1·55	100
200	1·25	.....	.....	.....	.....	.....	.....	.....	.....	1·34	1·22	1·22	1·20	1·45	1·50	200
300	1·20	.....	.....	.....	.....	.....	.....	.....	.....	1·35	1·20	1·20	1·18	1·40	1·45	300
500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1·18	1·15	1·35	1·40	500
1000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1·16	1·12	1·30	1·35	1000
2000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1·15	1·10	1·25	1·30	2000

Of multipolar machines the two best forms, magnetically, are respectively the inner polar type (column 13) and the radial multipolar type (column 12). In the first named of these types the magnetic types form a star, having a common yoke in the centre, and the polar pieces at the periphery; thus the distances of the leakage paths increase in direct proportion to the difference of magnetic potential, a feature which is most desirable and which accounts for the low values of λ for the type in question.

The most leaky of all types seem to be the horizontal single-horseshoe type (column 3) and the axial multipolar type (column 15). In the former type the excessive leakage is due to the fact that the magnetic circuit is suspended over an iron surface extending over its entire length, while in the latter type it is due to the comparatively close relative proximity of a great number of magnet cores (two for each pole) parallel to each other.

(To be continued.)

ELECTRICAL ENERGY—WHAT IT IS!

BY R. C. SHETTLE, M.D.

In the *Electrical Engineer* of December 7, under the title of "What is Gravity?" I put forward a theory relative to the formation of matter by which I defined the nature and cause of gravity. I pointed out that matter was endowed with various physical properties, in proportion to the quantity of the primary stuff which was differentiated for each form of matter, and to the particular character of motion which the quantities assumed under the general stress originated by the stuff undergoing formation into matter. I also described the ether as the residual stuff which had become very highly attenuated under the stress arising from the formed matter. It will be well now to consider the cause and nature of "electrical phenomena," and the relation they hold to matter under the same theory of gravity.

After what I have already stated with reference to the connection which exists between the material atoms and the attenuated original stuff, or ether, I think that the explanation of this form of energy is really very simple. The primary points for consideration are as follows: (1) That the earth is a highly porous form of matter. (2) That the interspaces are always occupied by ether. (3) That this ether exists in two conditions—(*a*) condensed on the surface of the atoms and partaking of their motions, just as the atmosphere partakes of the motions of the earth; and (*b*) in a free state and absolutely at rest, or nearly so, but, owing to its inertia and the motions of the earth, having a relative motion opposite to the motion of the matter. (4) That the ether in this state of rest or relative motion is retained in its normal degree of tenuity and tension by the stress of the surrounding masses.

Now, I venture to think that the ether is the basis of all electrical energy, and that just as under ordinary manifestations of energy the matter is the medium by which either potential or kinetic energy is perceived, so the ether is the medium by which changes of stress are shown, by whatever means they are originated. Indeed, if my theory is correct, it would seem that every change in the direction of what may be called the normal stress must be productive of effects upon the material atoms with which the ether is associated, not by friction, but by change in the direction of the strain, and these changes should be in proportion to the primary change of stress.

In formulating this theory of the cause of electrical phenomena, we have to consider (1) the free ether as the basis of the force, and that it is in direct contact with the atoms through the medium of the bound ether; (2) that its normal degree of tenuity is maintained by the stress of the formed matter; (3) that this free ether, in consequence of its inertia, has a relative motion opposite in direction to that of the earth, and as uniform in character as that of the matter; (4) that any local disturbance of these relations must proportionately affect the normal motion of the matter and the stress of the elastic ethereal medium. Therefore, in proportion as any molecular motion has been effected by friction or otherwise, and has modified the direction of stress, the stress natural to the matter must manifest itself in a direction which accords with the molecular disturbance, and the new set of phenomena must continue until the stress has resumed its natural direction by being absorbed into its normal condition. This explanation appears to me to satisfy all the points which demand attention in the evolution of static electricity, either in its terrestrial or artificial manifestation.

I will now consider dynamic or current electricity. It has been shown by Dr. Oliver Lodge ("Theory of Magnetism," page 173) that "The atoms of a particular substance—iron, for instance, or zinc—have an electric whirl of certain strength circulating in them as one of their specific physical properties. This much is certain, that the Ampèrian currents are not producible by magnetic experiments. When a piece of steel or iron is magnetised, the act of magnetisation is not an excitation of Ampèrian currents in each molecule—is not in any sense a magnetisation of each molecule. The molecules were all fully magnetised to begin with; the act of magnetisation consists merely in facing them round so as to look mainly one way in polarising them, in fact. This was proved by Beetz long ago. I will not stop to explain it further, but will refer students to Maxwell (vol. 2, chap. 6)."

I have quoted the above as having a peculiar interest in connection with my theory of gravitation and the cause of the physical properties of matter, as well as with the point now under consideration—viz., the circulation around the material atoms, not of "whirls" only, but of the very definite double helical currents which I have described. Therefore we have to recognise (1) that the earth is a reservoir of ethereal stuff which, to a large extent, assumes the form of currents circulating in helical directions around the atoms by its relative motion; and (2) that so long as the normal conditions of

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stress exist, there is probably no indication of these currents, more especially as currents of electrical energy; but as soon as bodies under different degrees of stress are associated by a medium (a conducting wire, for instance) by which those various degrees of stress can be made apparent, a current of this ethereal stuff is originated (which is, in fact, only motion in a new direction) in an effort to establish equilibrium of stress. Indeed, the current would seem to be the effect of an effort of the two bodies to establish balance of stress through the connecting medium. Upon this principle, the origination of static and dynamic electric stress appears to be as simple as is the flow of water from a higher to a lower level.

I would further suggest that in the generation of electric currents, the decomposition of the zinc element is due to the disruptive influence of the two currents exercised upon the surface of the weaker of the two forms of matter, upon the same principle as the disruption of matter would be effected (as I have shown in my paper on gravity) if the normal rotations of the atoms were terminated by the collision of the two masses.

I would add that the investigations which I have conducted into the character of other natural phenomena assure me that all—not excepting even the phenomena of animal life—are capable of being explained under the theory which I have now advanced as the nature and cause of gravity.

ELECTRICITY AND PLANT GROWING.

A paper on this subject has been contributed by Mr. L. H. Bailey, professor of horticulture at the Cornell University, Ithaca, New York, to the *Transactions* of the Massachusetts Horticultural Society. The paper was divided into two parts, one dealing with the application of electrical illumination to plant growing, and the other to the use of electricity or electric currents to plant growing.

With regard to the first, the author detailed a number of experiments, and concluded as follows: The electric arc light exerts a powerful influence upon plants in greenhouses, and all species, and sometimes even garden varieties, are affected differently. This varying influence is the effort of the plant to adapt itself to the new conditions in which it is placed, and the modification undoubtedly bears some relation to the elasticity or fixedness of the organisation of the plant, and therefore to the conditions under which the species has been evolved. And it must, therefore, follow that if plants were to be subjected to the electric light through several or many generations, more or less adaptive varieties would arise, in the same manner in which plants have adapted themselves by profound variation to the requirements of greenhouse cultivation. The electric light affects plants by hastening growth of maturity, but this effect may be so powerful as to destroy the plant. The injury is avoided, however, by screening the light through a glass, or by removing the plant to such a distance that the mischievous effect of the ultra-violet rays is dissipated. I consider it to be established that lettuce can be profitably aided by the electric light, and it is very probable that many flowers can be similarly benefited. Beyond this, I can only say that the fundamental principles involved are now pretty clearly understood, and that the near future should give us results of direct economic value.

Dealing with the second part, the author mentioned the attempts made to determine the effects of electric currents or electrification upon growing plants. He then continued:

Although it is not my purpose to analyse the results of the various experiments in the application of electricity to the soil, I wish to submit a few suggestions in passing. In the first place, it has not been proved, so far as I know, that the effects are due to the mere electrification of the soil. It is quite as probable that the injuries or benefits follow some chemical or mechanical effect which the current may exert upon the soil or the interstitial air. But what I particularly wish to say is that I have not yet read of an investigation in this direction which satisfies the demands of exact experimentation. The electric plots in these experiments are provided with wires or metal plates beneath the soil, while the control plots are left in a normal condition. The placing of the apparatus in the soil requires the removal and replacement of all or a part of the earth, and the soil is therefore in a different and usually better mechanical condition than that of the control plots. Or even if the soil were to be removed and replaced in the controls, the presence of the wires and plates would of itself introduce a great element of error, for the wires would become important factors in aerating and draining the soil and probably in modifying its temperature; and metal plates would certainly be likely to influence soil temperature. It is well known that in certain cases the germination of seeds can be hastened by running a twig down to them: it becomes a means of providing oxygen from the air, and probably also of relieving the soil of some of its superfluous water. One of the important advantages of ploughing under coarse manures or green crops is the mechanical effect which follows, for every strand of vegetable fibre forms a tube for the passage of water and air. And it has long been the practice in cool countries to put earthenware or other plates beneath fruit trees to warm their feet. While I am convinced that the application of electricity to the soil may produce marked effects upon vegetation, I shall not be ready to accept the results of experiments until the control plots are wired like the others—with non-conducting material, of course—and the temperatures and humidity of the soil are given careful attention.

It is very probable that atmospheric electricity exerts a powerful influence upon vegetation. The experiments of Grandeau were designed to determine this point. Plants were grown in the free atmosphere, which is always in a greater or less state of electrification, and also in a wire cage from which the atmospheric electricity was excluded. Maize in the free air was in every way better than the other, not only in the bulk of all its parts, but in the amount of ash, and of both nitrogenous and non-nitrogenous matters. Leclèrc, who made investigations at the same time, arrived at identical results. Grandeau's conclusions are as follows: (1) Atmospheric electricity exerts a considerable influence upon the production of vegetable matter. Other things being equal, plants will develop better when exposed to the influence of atmospheric electricity. (2) Plants deprived of the influence of atmospheric electricity have, in the same length of time, given 50 to 70 per cent. less bulk and 50 to 60 per cent. less fruit and seeds than the plants subjected to normal conditions—*i.e.*, those to which atmospheric electricity has free access. (3) The proportion of albuminous matter does not appear to be sensibly influenced by the electricity, but those plants from which the electricity is withheld appear to contain less water and more mineral content. (4) Tall plants have a mischievous influence upon the development of those which grow at their feet, not only because they deprive them of heat and light, but also because they absorb the atmospheric electricity.

Celi, shortly afterwards, reached similar results, while Naudin arrived at directly opposite conclusions. But the signal results obtained by the first three experimenters are generally accepted as strong evidence that normal atmospheric electricity is in some way beneficial to vegetation, and that in the experiments of Naudin there must have been some unknown conditions which obscured the results. By far the best investigations upon the electrification of the atmosphere in reference to plant growing with which I am acquainted are those made in Finland and France by Prof. Lemström, physicist in the university of Helsingfors.

It remained to determine whether the results obtained in Finland, which were favourable, can be expected in other parts of the world, or if they are possible only in high latitudes. The scene of experimentation was now transferred to France, where cereals, garden vegetables, and a variety of fruits were treated. An incident in this experiment was the behaviour of strawberries, which were subjected to an aerial discharge of from 2,000 to 3,000 volts continuously, night and day, from the middle of April to the middle of June. The first flowers appeared upon April 29 in the treated area, and upon May 7 in the other portion. The treated plants were in every way superior

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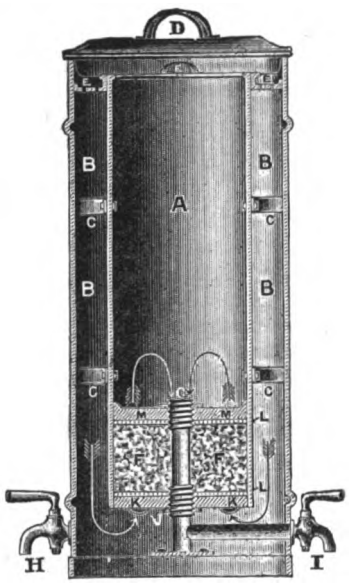
to the others until May 18, at which time there followed eight days of excessively hot weather. The treated plants languished, and the yield was much less than that of the normal area. The conclusion drawn from this interesting test is that the simultaneous action of electricity and high temperature is injurious to plants, and suggests that the electric current be discontinued in the hottest part of the day, as had been done in the Finnish experiments.

Although the remarkable experiments of Lemström have shown that the application of electricity to the atmosphere generally influences plants profoundly, and usually beneficially, it is yet undetermined just how this effect is brought about. It is highly probable, however, as Lemström himself suggests, that the modifications are not the direct result of electrification of the plants or the atmosphere, but rather follow some chemical change in the atmosphere which is engendered by the current. The experimenter is to continue his studies, and I expect to supplement them in America, for I consider it the most promising field in the many obscure inter-relations of electric energy and horticultural practice. I expect little practical result to follow any method of direct electrification of vegetation, but there is promise in those broader applications which intensify the normal processes of nature.

WILLCOX'S OIL-FILTER.

In the accompanying illustration is shown a new oil-filter, which has recently been placed on the market. This filter has



already been tested with satisfactory results in several central stations, where its adoption has resulted in great economy in oil, especially in connection with the collection of the used oil coming from the dynamo bearings. Where gas-engines are employed, this type of filter will also prove of value. It will be seen from the illustration that the construction of the filter differs somewhat from others. All the dirty oil is put into the outer chamber, and the oil is filtered by gravitation. The makers, Messrs. W. H. Willcox and Co., of 34 and 36, Southwark-street, S.E., state that the filter is one of the cheapest and best in the market. It can easily be cleaned out, it not being necessary to empty the filter to take away the dirty deposits. Referring to the cross-section, A represents the clean-oil chamber; B, the dirty-oil chamber; C are lugs on the clean-oil cylinder, so as to keep it central; D is a loose cover of the dirty-oil chamber; E is a loose cover of the clean-oil chamber, with perforated rim; F shows the filtering material; G is the clean-oil outlet tube; H represents the dirty-oil tap; I is the filtered-oil tap; J is the back-nut joint; K the lower grid; L the perforated zinc, and M the upper grid. In order to filter dirty oil the lid D is removed, and the dirty oil poured upon the lid E, when it will run through the perforation in the lid E into the dirty-oil chamber, B, forcing its way up through the lower grid, K, and the perforated zinc, L, through the filtering material, F, then when thoroughly cleansed it passes through the upper perforated zinc, L, and grid M into the clean-oil chamber, A, from whence it can be drawn off from the tap, I, through the tube, G, as indicated by the arrows. The filtering material can be easily removed when necessary.

MOUNTAIN RAILWAYS.

At the ordinary meeting of the Institution of Civil Engineers on Tuesday, Sir Douglas Fox, vice-president, in the chair, three communications having reference to mountain railways were read.

The first paper, by Mr. Sigvard Johnson Berg, A.M.I.C.E., was entitled "The St. Gothard Mountain Railway and the Stanzerhorn Cable Railway." In the great variety of systems presented by its railways, Switzerland might be said to exceed almost all other countries, especially in regard to mountain lines. The special nature of the work required for mountain railways in general, for their protection from floods, landslips, and avalanches, was first dealt with, and it was stated that only in recent years had the avalanche question been systematically studied. Avalanches were divided into two classes, described as "ground avalanches" and "snow-dust avalanches." The former occurred when a consolidated mass of snow was set in motion by thaw or other causes and descended at a comparatively slow rate, carrying earth, stones, trees, etc., along with it; the latter arose when the snow was newly fallen, and the temperature below freezing point, and they descended at a high velocity accompanied by a cloud of frozen snow-dust. A third type, sharing the character of both classes, was also mentioned. All risk from avalanches might be disregarded on a well-wooded hillside. Protection might be obtained, where necessary, in two ways: either by building the line in a tunnel or gallery, or else by works of defence adapted to arrest the movement of the snow. In constructing galleries, care should be taken to avoid placing the entrances to them in deep cuttings, and cuttings at the entrances to galleries should be levelled down on the side towards the valley. Barriers made to arrest avalanches were sometimes of dry-stone walling, and sometimes of timber or iron posts with rails or wattlework. These barriers were distributed in short lengths over the ground where avalanches were likely to originate, with their sides at right angles to the probable direction of motion. When timber posts were used, they were, as a rule, from 5ft. to 6ft. 6in. in length, and about 6in. in diameter. In steep gorges, snow bridges, like hurdles, placed horizontally in the angle of the gorge, were used to break the force of a descending avalanche, although not adequate to stop it altogether. In concluding this part of the communication, a detailed account was given of the St. Gothard Railway.

The author next described the Stanzerhorn cable railway, which ascended from the Lake of Lucerne to near the summit of the Stanzerhorn, 6,230ft. above sea-level. The line was divided into three sections, with a power station at each division. By this means a better alignment was obtained than would have been possible if one cable had been used throughout. The capacity of the line for traffic was also increased and the length of the cables reduced. The motive power was electricity, generated by a hydraulic motor at a distance of 2½ miles. The generating station also supplied power to other consumers. The power stations were furnished with steam-engines as a reserve. The line had two rails, except at loops, midway of each section where the "up" and "down" carriages passed. The gradients on the lowest section commenced with 1 in 12·5 and ended with 1 in 3·7. The other sections both began with 1 in 2·5 and ended with 1 in 1·6. The speed on the first section was 6½ft. per second, and on the others about 4½ft. per second. The whole journey occupied about 45 minutes, each section taking about 13 minutes. Each section had a fairly straight alignment, the highest section having the greatest curvature, amounting in all to 56deg. The points at the passing places were automatic, the outer rail being continuous in each case and the wheels on one side of each carriage having double flanges, while the other wheel was without flanges. No rack was used, this being considered a source of danger on such steep gradients from the possibility of the pinion mounting the rack teeth. The longitudinal section of the line approached closely to the ideal profile requiring uniform motive power. The gauge was one metre. Steel sleepers weighing 51lb. were used on the lowest section with rails

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of 40lb. per yard, in 10 metre lengths, spaced one metre apart. The permanent way was anchored by vertical joists in blocks of concrete at every fourth rail joint. On the two upper sections the permanent way was the same except that iron angle-bars, 5in. by 3½in. by 5ft. long, were used as sleepers. The cable on the lowest section was 0·9in. in diameter, weighing 4¾lb. per lineal yard, and having a breaking strength of 24½ tons. The cables of the upper sections were correspondingly heavier. The stress on the cable in the lower section, with a fully-loaded car ascending, was 3,873lb. at starting and 3,942lb. at the end of the journey. A telephone wire was carried along the line, so that the conductor could signal to the engine-house from any point on the line. The cost of the line was £58,000, and the builders contracted to work it for the sum of £1,500 per annum, paying all expenses except renewal of cables and insurance of the passengers.

In an appendix statistics were given of a number of Swiss mountain railways, classified according to the methods in which they were operated.

THE ELECTRIC LIGHT AT THE MUNICIPAL OFFICES, BOMBAY.

The new Municipal Offices, Bombay, have been fitted up with the electric light on the alternating-current transformer system. The installation is of an ornamental type, as befitting the architectural surroundings.

We note, says the *Indian Engineer*, in passing, that the Bombay Municipality has been popularly credited with the announcement, made in broad daylight before the assembled members by one of the councillors, and supported by others, that the electric light is still in its infancy. As a result, we notice that, after spending several thousands of rupees on the installation of the electric light in the Municipal Offices, the councillors have decided to dispense with the services of an electrical engineer on the score of economy. Accordingly at the time we visited the offices, it was placed in charge of the superintendent of the municipal workshops. For the following information our acknowledgments are due to the chief engineer to the Bombay Municipality, Mr. M. M. Marzban, C.I.E., and to Mr. Hewett.

The Dynamos.—The principal dynamo is operated by an exciter, while both are driven by belting attached to suitable pulleys on the same shaft. The main dynamo is a compound-wound Thomson-Houston machine, capable of giving an alternating current at a pressure of 1,100 volts. The frame of the dynamo consists of two parts, horizontally secured by bolts; while the field wire is wound on 10 brass bobbins attached radially to the frame. There are two sets of wire coils, of thin and thick wire respectively, the sizes of which are selected to limit the loss below 5 per cent., the coils being grouped in series in each set. The bobbin frame is cast in a separate piece from the base, so that the former can be made to slide on the latter. The tension on the leather belt is regulated by means of a screw, attached to the base-plate, by which the bobbin frame could be shifted forwards or backwards. The armature revolves at the rate of 1,500 revolutions per minute. The foundations consist of wood and concrete, with bolts passing through. Stiff copper wire brushes are used, with the collectors, of which there are two sets, on the shaft of the armature, one set leading the direct current from the exciter dynamo into the field magnets; the other set supply current into the mains. The field coils are removable for repairs. The dynamo field is supplied by a part of its own current, which is returned through the commutator into the field coils, in addition to the current supplied by the exciter dynamo. The armature is hollow and well ventilated. The exciter dynamo is a Thomson compound-wound incandescent dynamo, of the single-horseshoe type, vertical. It is driven off a special pulley on the shaft which carries the pulley for the principal dynamo. The armature revolves 2,400 times per minute, and a pressure of 110 volts is attained at the terminals of the dynamo.

The Steam-Engine.—The motive power for the dynamos is supplied by a compound non-condensing stationary engine of 90 h.p., by Marshall, Sons, and Co., Limited, Gainsborough. The engine, which is of the underneath type, is combined with a locomotive multitubular boiler. It is erected on a wrought-iron frame, and is surmounted by the boiler. The fixing is thus of a simple character, and when the boiler is filled with water it tends to keep the entire structure rigid during work. The engine is fitted with patent automatic expansion gear, by which the steam is cut off at any desired point of the stroke at nearly boiler pressure, and is expanded to the utmost advantage. Uniformity in speed and economy in coal consumption are also secured. An outer bearing and standard with a fly-wheel are provided, as also an automatic sight-feed lubricator, a steam-trap for drawing cylinder jackets, etc. The power utilised at present comes up to about 65 h.p.

Accessories.—Thomson-Houston measuring instruments are used, the voltmeter being used with its own transformer. A special transformer is also provided with the pilot lamp in the dynamo-room to light the measuring instruments. An ammeter reading up to 40 amperes is used, the full-load current rate at present used being only about 25 amperes. The voltmeter is capable of reading up to 52 volts only, and is provided with a transformer which can convert the current pressure supplied to it from the dynamo to a pressure of 100 volts. The secondary coil of this is, however, constructed in two sections, which, being connected in parallel, the use of the low-reading voltmeter with it is possible. Rheostats and lightning arresters are fixed in the engine-room.

Underground Mains.—The main current at high pressure (1,100 volts) is conveyed by underground mains, passing along Palton-road and Hornby-road into the transformers in the Municipal Offices, a distance of about a quarter of a mile; indiarubber and lead-coated conductors are used for the purpose, led through cast-iron pipes, with draw-boxes about 100 yards apart.

Transformers.—The transformers are arranged, along with the measuring instruments of the Thomson-Houston type, in a room beneath the large staircase of the Municipal Offices, and are laid out in three sets, one for each flat. They convert the current from 1,100 to 100 volts. Thus, three main circuits in parallel run out of the transformer-room and enter.

Distributing Boards and Lamps.—There is one of the former on each flat. The lamps are incandescent lamps, varying between 16 c.p. and 50 c.p. each, of the Edison-Swan type. They are provided with the Edison-Swan patent contacts and bayonet joints, screw ribbon contacts being provided with the 50-c.p. lamps. Switches are attached to the main circuits, and one with each lamp, besides the double-pole main switch in the engine-room. Three ornamental chandeliers are suspended in the Council-hall, each containing 13 lamps of 50 c.p. each, with frosted glass covers.

Proposed Extensions.—For the present, the installation has been allowed to lie idle, as it has not been considered advisable to maintain a staff for the few hours' lighting required per week at the Municipal Offices. It is proposed, however, to light the Crawford Markets by making slight modifications and additions to the existing plant. We hope the extension work will be taken in hand early, to save the existing plant from deteriorating for want of use.

THE BRITISH CABLE—THE UNITED STATES AND HAWAII.

The *Times* of yesterday publishes a telegram from Washington stating that further official correspondence has been published regarding recent events in Hawaii. It supplements Admiral Walker's report, reveals differences of opinion between Admiral Walker and Mr. Willis, the United States Minister, and refers also to the endeavour made by the British Government, with the consent of the Hawaiian authorities, to secure the lease of an island in the Hawaiian group to be used as a cable station.

On October 13 Mr. Willis wrote to Mr. Gresham, Secretary of State, regarding the negotiations then proceeding between Hawaii and representatives of Great Britain with reference to the laying of a cable which should touch one of the islands. Mr. Willis said: "Mr. Sandford Fleming, the Canadian representative, and Mr. Mercer, of the British Colonial Office, accompanied by Mr. Hawes, the British Commissioner in Hawaii, have returned from Bird Island, which they have visited in the interests of the proposed cable. They will return by way of Washington, and will probably submit to the President and yourself some proposal. M. Verlaye, the French Commissioner, requests your attention to the possible extension of the French cable from New Caledonia to the United States, and he therefore hopes that the United States will not be hasty in arriving at a decision."

On December 3 Mr. Willis again wrote to Mr. Gresham as follows: "In Hawaiian opinion, Hawaii is estopped from considering the proposal of the British Commissioners by the reciprocity treaty with the United States. . . . . This matter is, therefore, at the request of Hawaii, submitted to the consideration of the United States upon the question of the willingness of the latter to modify the reciprocity treaty by exempting an island from the operation of the clause preventing any special privilege being granted to another Power."

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Mr. Willis encloses a note from Mr. Hatch, Hawaiian Minister for Foreign Affairs, expatiating on the importance of the cable to Hawaii, and saying that the opportunity was one to which Hawaii could not be indifferent, if it could be taken up consistently with treaty obligations, and no scheme more desirable were presented. Mr. Hatch proceeded to say that as the proposal was one in which Great Britain was directly or indirectly interested, Hawaii felt estopped by the reciprocity treaty from considering it until the views of the United States had been ascertained. Mr. Hatch enclosed a letter from Mr. Sandford Fleming and Mr. Mercer transmitting copy of the memorandum of agreement, and stating that they presumed that Mr. Hatch would bring the proposed arrangement to the notice of the United States and ascertain whether the latter would give their consent.

Mr. Fleming and Mr. Mercer, moreover, pointed out the advantages accruing to the United States from the proposed cable. They observed that it was by no means a settled undertaking to be carried out as a Government enterprise, but that it might be committed to a company whose lease would not literally come within the terms of the treaty. Having regard, however, to the circumstance that foreign Governments would have a substantial interest in the lease, the British and Canadian Commissioners quite agreed with the suggestion that the agreement in any shape should have the sanction of the United States. The subsidy demanded was £7,000 per annum for a period of 15 years.

The above correspondence was sent to Congress on Wednesday, with a message from President Cleveland, in which the latter says: "I submit herewith certain despatches from our Minister in Hawaii and the accompanying documents. They disclose that Hawaii desires to lease to Great Britain one of the uninhabited islands as a station for a submarine telegraph cable between Canada and Australia, with connection between the island leased and Honolulu. Both Hawaii and the representatives of Great Britain in the negotiations concede that the proposed lease cannot be effected without the consent of the United States owing to our reciprocity treaty with the king. The latter agreed that as long as the treaty remained in force he would not lease, otherwise dispose of, or create a lien upon any port, harbour, or other territory in his dominion, or grant any special privilege or right of use therein to any other Power, State, or Government. At the request of Hawaii this subject is laid before Congress for its determination upon the question of so modifying the treaty as to permit of the proposed lease. It will be seen that the correspondence between Hawaii and the British negotiators negatives the existence on the part of Hawaii of any suspicion of British unfriendliness or fear of British aggression. The attention of Congress is directed to the following statement contained in the communication addressed to Hawaii by the representatives of Great Britain: 'We propose to inform the British Government of your enquiry whether they would accept the sovereignty of Neckar Island, or of some other uninhabited island, on condition that no subsidy be required from you. As we have explained, we have not felt at liberty to entertain that question ourselves, as we were definitely instructed not to ask for the sovereignty of any island, but only of a lease simply for the purpose of the cable.' I hope Congress will see fit to grant the request of Hawaii, and that our consent to the proposed lease will be promptly accorded. It seems to me we ought not, by a refusal of this request, to stand in the way of the advantages to be gained by isolated Hawaii through telegraphic communication with the rest of the world, especially in view of the fact that our own communication with that country would thereby be so greatly improved without apparent detriment to any legitimate American interest."

WORK OF AN ELECTRIC CURRENT.

At the Royal Institution on Thursday afternoon of last week Prof. J. A. Fleming, F.R.S., gave the fourth of his Christmas lectures on "The Work of an Electric Current." Before dealing with the proper subject of the day's lecture, which was the current working as an illuminator, he performed some additional experiments in illustration of the current's heating effects. He first demonstrated the curious properties, discovered by Peltier, which are possessed by a certain form of bismuth-antimony junction. A current passed through it in one direction develops heat, in the other cold; while, reversely, the application of a piece of ice to it produces a current. It is also capable of acting, to a slight extent, like a secondary battery, for after being subjected to a current for a short time it is able in turn to give one off. The utilisation of the heating effects of the current in the construction of instruments for the detection of minute electric currents was explained. A narrow strip of platinoid, twisted and fixed at its ends, will untwist slightly when a current is passing through it, and its movement may be observed by appropriate means. Prof. Fleming then passed to the consideration of the illuminating powers of the current. These, he said, may be obtained in two ways—either by heating a conductor by a current to incandescence, or from the electric discharge taking place through gaseous non-conductors. The discharge in the latter case assumes four forms; it may appear as a spark, a brush, a glow, or an arc. A spark was described as the light and heat produced when the strain in the non-conducting air between two oppositely-charged conductors becomes greater than it can support. No strain, and therefore no spark, can occur unless there is electric pressure, and so Prof. Fleming digressed to explain the Wimshurst machine, which generates a very minute current of electricity at very high pressure. He emphasised the fact that the current given off by this machine (of which a very large specimen, with six pairs of plates, was exhibited) is identical in kind with that obtained from a voltaic cell. The difference between the two he described as analogous to that between a large quantity of water falling from a small height and a little water falling from a great height, the current from the machine corresponding with the latter. He then pointed out the shortness of the duration of the spark discharge, and described the revolving mirror apparatus employed by Sir Charles Wheatstone to measure it. Increasing knowledge, however, he said, has proved that the duration depends on a variety of circumstances, and it is impossible to assign any particular length of duration to the spark in general. He produced a splendid display of long sparks, in illustration of the disruptive power of the discharge, by connecting the terminals of the machine to two tall glass vessels lined with tin foil and standing on a sheet of gold foil. The brush discharge was next considered, and it was shown that when two charged conductors are more widely separated than is necessary for the spark discharge the air space between them is filled with a rosy-purple light. The effect appears continuous, but really is not so; it is supposed to be caused by the alternate charge and discharge of the particles of air. The glow produced by discharge in a rarefied atmosphere was next shown, and the phenomenon of fluorescence exhibited by means of uranium glass. The stratified discharge was shown in tubes containing minute quantities of hydrogen, turpentine, and sulphuretted hydrogen respectively, and the wind given off by a pointed conductor was used to blow out a candle. Prof. Fleming then dealt with the arc discharge, which, he remarked, was first obtained by Davy in the Royal Institution, and images of the arcs made between iron and carbon points were thrown on the screen. After briefly explaining the conditions necessary to the production of this form of discharge, the lecturer passed on to consider the other way of obtaining light from electricity by using it to heat a conductor to incandescence, and concluded with a short description of the manufacture of the incandescent lamp.

The fifth of Prof. J. A. Fleming's Christmas lectures on "The Work of an Electric Current" was delivered on Saturday afternoon, and was devoted to the consideration of the current working as a messenger. Prof. Fleming began by stating the elementary facts upon which depends the action of the electric telegraph, and passed in review some of the principal types of instrument now employed. He mentioned Oersted's discovery of the influence exercised on a movable magnetic needle by the passage of a current in a neighbouring conductor, and showed that a bar of iron is magnetised when a current is sent through a coil of wire wound round it, the intensity of effect produced varying with the quantity of wire in the coil. By experiment it was proved how quickly the iron, if pure, becomes demagnetised when the current is stopped, and to illustrate this fact the construction and action of an electric bell were explained. The single-needle telegraph instrument, together with the older form having five needles, was then described, and consideration of the complexity of the latter suggested the remark that it seems to be a law of invention that simple methods of attaining a given end usually result from the progressive improvement of others more difficult and complicated. An explanation of the combinations of right and left beats of the needle, and of dots and dashes, to denote the different letters of the alphabet was followed by a brief account of the Morse printer and sounder. The next instrument discussed was the mirror galvanometer, devised by Lord Kelvin for use with the short-lived Atlantic cable of 1858. Prof. Fleming gave directions by which for a few pence a home-made mirror galvanometer might be constructed which would give results practically as good as those obtained from an expensive instrument made by a first-class maker, and explained how to make a battery for use with it out of a tin can, some iron filings, a porous pot, a piece of zinc, and some washing soda. He then described Kelvin's syphon recorder as employed on almost every long ocean telegraph, and, returning to land-line instruments, dealt with the Wheatstone automatic transmitter, by the use of which the report of a big speech may be simultaneous despatched from one centre to the newspapers in a dozen or more towns. He mentioned that when Mr. Preece was put in charge of the postal telegraphs the average speed of these transmitters was about 80 words a minute, while

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now they are worked up to 600. The lecture concluded with an explanation and exhibition of Gray's telautograph, which does not transmit the signals of a code, but reproduces on its receiver a facsimile of the writing traced at the sending station. Even sketches can be sent through it, and it has been successfully worked over the telephone cable between Paris and London. By the kindness of the postal authorities a couple of their operators were present to show the working of the various telegraphs described by the lecturer, the instruments employed being also lent by the Post Office.

The sixth and last of Prof. J. A. Fleming's Christmas lectures was delivered on Tuesday. After mentioning the ingenious typewriting telegraph invented by Prof. Hughes, which has the advantage of requiring on an average only a third of the number of currents necessary for the Morse instrument, he made a few remarks about the telephone. He first explained Ohm's law of the relation between current, E.M F., and resistance, and then showed the experiment with which was closely connected the invention of the microphone by Hughes. If a number of plates of carbon are piled one on the other, the electrical resistance of the pile is diminished when the plates are pressed together, and increased when the pressure is removed. The microphone essentially consists of a piece of carbon resting lightly on another piece, and it is found that the electrical resistance of such an arrangement is sensibly affected by the slight changes in the pressure upon it caused by the air-waves which are set up by the speaking voice. It can, therefore, be used as the transmitter of a telephone. The receiver is constructed by taking advantage of the fact that the strength of an electromagnet varies with the current circulating in its coils. If a thin iron plate be fixed in front of a permanent magnet wound with wire like an electromagnet, and if the current flowing in the wire be passed through a microphone, the attraction on the iron plate will vary exactly with the variations of pressure sustained by the microphone, and therefore the iron plate will move and set up the same vibrations in the air as were present in the air surrounding the microphone. Prof. Fleming then passed to the consideration of the current working as a force. He first showed Faraday's experiment of the production of a current by rotating a copper disc between the poles of a magnet. He used Faraday's own machine, and exhorted his audience to regard it with reverence, for on it was performed the fundamental experiment which led to the construction of all the machines now used for the transformation of mechanical power into electricity. He then drew attention to the broad principle that whatever physical process can produce a current can reversely be produced by a current, and in illustration showed how Faraday's experiment can be reversed and a copper disc made to rotate by passing a current round the magnet. This last experiment he described as being the progenitor of the motor, just as the other one was of the dynamo. He then briefly traced the development of the dynamo. The first improvement was the substitution of bobbins of wire for the copper disc, and the next the multiplication of the bobbins and magnets as in the Alliance magneto-machine, which is not yet obsolete, since it is used, among other places, at the lighthouse on St. Catherine's Point, in the Isle of Wight. The next improvement was made by Siemens, who altered the form of the bobbin, and wound it on a different plan; he was also able to design his machine so as to utilise more of the magnetic field than had hitherto been done. About 1866 Varley and Siemens almost simultaneously made the discovery that electromagnets, excited by the current produced by the machine itself, can be used in place of permanent ones, and this, together with the invention in 1870 of Gramme's ring, a new and more efficient form of armature, was the foundation of modern dynamo construction. As regards the development of the electric motor, Prof. Fleming said that 20 or 25 years ago it became clear to electricians that the dynamo is a reversible machine—that is, can either be used to transform motion into electricity or electricity into motion. Attempts had been made to construct motors which depended for their action on the attraction and repulsion of magnetic poles. Such motors, indeed, moved, but they were very inefficient, and could do no work, resembling an idle boy who eats a great deal but does very little for his food. Prof. Fleming was very particular to point out that motors, as now constructed, are practically reversed dynamos, and that the amount of energy they consume varies strictly as the work they have to do. Engineers, he said, are beginning to see the advantages of electrical distribution of power, and quite lately he visited an engineering shop every tool in which was driven by a separate electric motor. Some photographs were shown on the screen illustrating the employment of electricity for such purposes as traction and hoisting. Prof. Fleming then spoke of the long-distance transmission of electricity by alternating currents, which differ from continuous ones something in the way a tidal river with its ebb and flow differs from a non-tidal one, and showed an alternating-current motor in action. This was unable to start itself, but when once it was started and had "got into step" with the dynamo at Deptford (seven or eight miles away) which supplied the current it would continue to run at the same speed as the dynamo, unless so heavy a load were put upon it as to cause it to slow and get out of "step." In conclusion, the lecturer made a few remarks on the nature of the electric current. The question, What is electricity? is a natural one to ask, but one which does not admit of a short and direct answer. A high place must be given to the discovery, which, if not absolutely demonstrated, is most probably true, that space is not empty, but filled with a something which has been called ether. There is abundant proof that light is due to a series of changes in this ether. We do not know the nature of these changes and are not justified in calling them motions, but we may regard them as very short waves. Faraday held the opinion that electricity depends on analogous changes in a medium or ether, and Clerk Maxwell elaborated the theory, while Hertz, who only died last year, invented what may be called an electromagnetic eye which can detect long waves, several yards in length, just as our eye detects short waves. The existence of this electromagnetic medium must be regarded as highly probable. Prof. Fleming then thanked those who had assisted him in his lectures and had lent him apparatus, and hoped that some of his hearers might be attracted to the further study, and especially experimental study, of electricity, promising them that they would thus open up to themselves a boundless region of pure and permanent pleasure.—*The Times.*

THE EXPLOSION IN EUSTON ROAD.

An enquiry was held at the St. Pancras Vestry Hall yesterday by Major P. Cardew, on behalf of the Board of Trade, into the explosion which took place at midnight on December 29 in the Euston-road, to which we referred last week. Prof. Robinson was present on behalf of the Vestry; Messrs. Bassett Hopkins and Gunyon on behalf of the London County Council; and Mr. Foulger on behalf of the Gaslight and Coke Company.

The first witness called was **Police-Constable James Diprose.** He stated that on the night in question, while at the corner of Endsleigh-gardens and Gower place, he heard an explosion in the Euston-road, and just on arriving there a second explosion took place. He saw three or four of the flagstones at the electric manhole fly into the air to a height of about 20ft. He saw no flame, but there was dense smoke. Turning along the Euston-road about a distance of 20 yards, he found the cover of a manhole displaced and lying about 8ft. from the manhole. It was not broken. About 45 yards of the pavement were raised. He then informed the electric light department and the gas company. Two men named Petrie and Govier informed him that they had been hurt. There was a smell of coal gas at the corner manhole.

In reply to **Mr. Gunyon**, he said that what he took to be flagstones in the air was probably the cover of the manhole.

Mr. Charles Govier said that while coming along the Euston-road from Gower-street with his friend Petrie he saw a flash and was hurled into the air, coming down on his back. Then the ground heaved up and he was thrown into the gutter. He did not see a second flame. On getting on to his legs again he found Petrie, who said he felt dazed, holding on to the railing. With assistance they walked to University College Hospital, where his side was strapped up. He had sustained a shock to the system, and still felt pain. He had not smelt any gas.

Mr. Edward Pycraft, chief clerk of the St. Pancras electric and public lighting department, said that on behalf of the Vestry he had called at the hospital to enquire into the cases referred to. The house-surgeon's report was that Govier had a bruised side and Petrie a sprained ankle. Both of them were stated to be mild cases.

Mr. James Thomas Baron, chief engineer of the St. Pancras electric light station, stated that he had under him Mr. Thomas, an outdoor inspector, who reported to him the result of his inspections. The manholes were inspected about once in four to six days, both for water and for gas, the gas being traced by smell. Both the manholes relating to the explosion had been inspected the day previous to the event. The presence of gas in the culverts had been a source of trouble for some time past, and where smells had been observed more frequent inspections were made. The gas which was perceived was coal gas. The manholes were drained into and trapped from the sewers. At one of the manholes in question no gas had been traced since July last, but at the second, gas had been found on November 15 and December 13 last. The Gaslight and Coke Company were written to on December 14 that the culvert was highly charged with gas, and asking that attention should be paid to the matter. The gas company did not reply to the letter, but he heard that their men had opened the ground on December 14. On the night of the explosion he was told of the occurrence by a policeman, and he reached the spot about a quarter of an hour afterwards. He found a length of about 30 yards of the pavement raised from 2in. to 3in. He noticed a smell of coal gas at one of the manholes. The two manholes, which were 10 yards apart, were connected by an 8in. iron pipe, containing three strips of bare copper wire supported on porcelain insulators, this method being adopted in certain places

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where other pipes had to be crossed. After the explosion he examined the copper strips, and found them in good condition. There was no electrolysis. The insulators had been displaced by the force of the explosion. The fuses, consisting of tin strip, had not been affected. The brickwork of one manhole was much shaken, and the cover of iron, filled in with York stone, was broken. The cover of the other manhole was displaced. On the morning of Sunday, December 30, he, in company with Mr. Man, of the gas company, inspected the manholes in the vicinity. There was no gas, but the manholes had been open. At the one manhole there was on the negative side insulator a slight incrustation. This had been analysed, and consisted of a salt with a slight proportion of caustic soda. They frequently found incrustations in the manholes, but none in the culverts. The copper strips were in as good condition as when laid down. There were about 6½ miles of mains on the culvert system. Up-cast pipes had been put in after the Endsleigh-gardens explosion of January 12, 1894. There used to be pilot wires in the culverts, but these had been removed. There were 11 ventilating pipes in all, and three ventilating covers to manholes. The inspection tubes in the manhole covers also acted as ventilators. This work had been carried out on the recommendation of Major Cardew after the explosion of a year ago. With respect to his recommendation to have wooden shields in the chambers, such had been fixed in many cases, but they got wet, swelled, and broke away. As regarded the recommendation to substitute two small chambers for one large one, there had been a practical difficulty in the way. When they found the insulation of the negative low, they took steps to clean the insulators.

In reply to **Mr. Bassett Hopkins**, the **Witness** said there had not been any short-circuit There was certainly coal gas there, and there might have been a spark.

In reply to **Mr. Foulger**, he said that the gas company had attended to the complaint by sendnig men. The conductors were fairly light, and separated by distance-pieces at intervals of about 3ft. The mains certainly could not have come into contact with each other, for if they had the fuses would have been blown out, and they had not done so. He had, however, known of one case, about 18 months ago, where mains had touched, though he did not know the cause There could not have been any hydrogen gas produced by electrolysis of the moisture. He had smelled coal gas since the explosion. He had heard that the gas company's officials had been testing daily and not found traces of gas. The incrustration on the negative insulator might have had something to do with the matter.

Mr. William John Thomas, outdoor inspector of the electric light department, stated that he had charge of the mains and house connections. He desired to correct Mr. Baron in regard to two points: firstly, the manholes were inspected at least once in three days, and, secondly, there were four ventilating covers, not three. He had noticed a strong smell of coal gas at a manhole 43 yards away from one of those where the explosion occurred. On December 31 he smelled gas, and drew the attention of Mr. Gunyon and Mr. Champion, officials of the London County Council, to the fact. On December 13 one of his men reported a smell of gas. He did not consider the gas detector used by the gas company as an efficient instrument. On December 30 he tested the section in question, which gave a low insulation, but he had known it as low before. In his opinion the ventilation was not sufficient to get rid of the coal gas, which was their greatest danger.

Mr. Foulger suggested that the smell which had been noticed was due to the smell of the gas-main in the neighbourhood and not to coal gas itself.

Prof. Robinson pointed out that if this were the case, the smell would be constant and not intermittent.

Mr. Edward Bennion, electrical jointer and foreman under Mr. Thomas, had examined the fuses and found them all right. He had smelled gas after the explosion. The following morning he went with Mr. Man, of the gas company, and the gas detector was put down, but did not move. It was also put down over a gas jet with the tap turned full on, and it did not move till after a lapse of three to four minutes. He agreed with Mr. Thomas as to the inefficiency of the detector.

Mr. William Nisbett Blair, borough engineer and surveyor to the Vestry, owing to the suggestion that sewer gas might have something to do with the explosion, had examined the sewer and found the air unusually free from smell. At an electric manhole in the neighbourhood he had found a smell of coal gas in the presence of one of the gas company's men, but the instrument failed to move. Sewer gas *per se* was not explosive, but he had known explosions take place in sewers owing to the presence of coal gas. His men worked in the sewers with naked lights.

In reply to **Mr. Foulger**, he said he could tell the difference between the smell of coal gas and the waste products from an indiarubber works. Besides, there was no rubber factory in the parish.

Mr. G. F. L. Foulger, engineer to the Gaslight and Coke Company, stated that the whole of the tests they had applied failed to show the presence of gas anywhere near the locality. He was present out of respect to the Board of Trade, and not because his company admitted any liability in the matter.

In reply to **Prof Robinson**, he said that gas unaccounted for amounted to 4 per cent., but he thought that actual leakage amounted to only 1¼ per cent. He attributed the explosion to an accumulation of hydrogen gas evolved by electrolysed moisture on the insulators, and that this had been exploded by sparking.

Major Cardew pointed out that in such an event there would have been corrosion on the conductors, which was not the case.

Prof. Robinson said that he had advised the Vestry to supplement the present ventilation by a more thorough system which would avoid any future explosions of gas.

The enquiry then terminated.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Saint-Die (Vosges, France).—The Municipality invite tenders by February 1 for the concession for a central electric light station for the town.

Stockport.—Tenders are invited for providing and fixing complete a fuel economiser, for the Corporation. We have already given particulars. Tenders are to be delivered by 16th inst.

Louvain (Belgium)—Tenders are invited by February 1 by the local authorities at the Hotel de Ville for a concession for an electric tramway from the railway station to the Grand Place, Louvain.

Nelson.—Tenders are invited for lighting Stanley-street Chapel, Nelson, with electricity. Particulars are obtainable from Mr. James Bateson, 10, Primrose-street, Nelson, to whom tenders are to be sent by the 18th inst.

Birmingham.—The committee of the Birmingham Municipal Technical School invite tenders for the installation of the generating plant, etc., in the new school. Particulars have already appeared in our pages. All tenders must be sent in to Mr. Geo. Mellor, secretary, by to-morrow.

Ludlow.—The Corporation require tenders for providing a means of automatically indicating in the town the depth of water in the reservoir, situate on a hill about 800 yards distant. Full particulars can be obtained from the borough surveyor. Tenders are to be sent to Mr. Williams, the town clerk, by the 18th inst.

Nottingham.—Tenders are invited for the supply of lamps, lamp columns, etc. Further particulars and forms of tender may be obtained of Mr. Rhodes, lighting inspector, St. John's-street. Tenders to be sent to Sir Samuel G. Johnson, town clerk, Guildhall, Nottingham, by 11th inst., endorsed "Tender for Lighting Requisites."

Bristol.—Tenders are invited for the installation of the electric light at the Guildhall and a portion of the Council House, for the Corporation. Plans may be seen at the office of the city electrical engineer, Mr. H. Faraday Proctor, A.M.I.C.E., M.I.E.E, Temple-back, from whom specifications may be obtained. Tenders to be sent to the chairman of the Finance Committee, the Council House, Bristol, by January 18, endorsed "Tender for Electric Light Installation."

London.—The Metropolitan Asylums Board, as will be seen from our advertisement columns, invite tenders for the supply and running of mains, and the wiring of the buildings and grounds of the North-Western Fever Hospital, Haverstock-hill. A copy of the conditions of contract and specification may be purchased at the offices of the Board, Norfolk House, Norfolk-street, Strand, London, W.C., and the plans can be seen at the hospital. Tenders are to be delivered at the offices of the Board not later than Thursday, the 24th inst.

RESULTS OF TENDERS.

Stafford.—The Town Council have accepted the tender of the Electric Storage Syndicate for the construction of the accumulators at a cost of £822, and one of £524. 18s. from the Electric Construction Company (Wolverhampton).

Aberdeen.—The Finance Committee of the Town Council have provisionally accepted the offer of Messrs. New and Mayne to furnish the wiring for the electric light in the Municipal Buildings. The Corporation's engineer will erect the fittings.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,253.

Great Northern Telegraph Company.—For the month of December the receipts were £24,800.

Fleetwood.—The Urban District Council have met in committee to consider the electric lighting question.

Rottingdean.—A scheme is on foot for the electric lighting of Rottingdean, with an extension of mains to Ovingdean.

Harrow.—Messrs. Crompton and Hawtayne have purchased the electric lighting provisional order obtained by the Harrow Local Board.

Dublin United Tramways Company.—The Board have declared a dividend at the rate of 5 per cent. per annum for the latter half of 1894.

Eastern Telegraph Company.—The receipts for the month of December were £55,593, as against £55,579 for the corresponding period of 1893.

Direct Spanish Telegraph Company.—For the month of December the receipts were £1,671, as against £1,895 for the same period of 1893.

Carnarvon.—Mr. Issard Davies said at a recent meeting of the Town Council that if they could not get better gas they had better introduce the electric light.

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Eastern Extension Telegraph Company.—For the month of December the receipts show an increase of £2,877 as compared with the corresponding period of 1893.

Burnley.—The Town Council have decided to increase the remuneration of Mr. F. Thursfield, the municipal electrical engineer, from £150 to £200 per annum.

Windermere.—The Urban District Council have appointed Messrs. Garnett, Fell, Irving, and Latham to deal with the electric lighting company's application for a provisional order.

City and South London Railway.—The receipts of the Company for the week ended January 6 were £1,004, against £990 for the corresponding week of 1894, or an increase of £14.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 6th inst. amounted to £926, as compared with £688 in the corresponding week of last year.

Surbiton.—The Electric Light Committee appointed by the Urban District Council consists of Messrs. Gibbes, Thynne, Marshall, Lapage, Judd, and the chairman (Mr. Guildford).

Weston-super-Mare.—The new members of the Lighting Committee of the Urban District Council are Councillors Boyden, Phillips, Heap, Deverell, Gill, Ball, Dubin, Clark, and Bryant.

Canterbury.—The Town Clerk has informed the Town Council that nothing has been heard from the Brush Electrical Engineering Company withdrawing their claim to the electric lighting order.

Salisbury.—The Town Clerk has informed the Town Council that he has received two copies of the electric lighting company's license as finally issued by the Board of Trade. It is practically what the Council have already approved.

Technical Institute Lighting.—The order for the electric lighting of the new county technical instruction buildings, Stafford, has been placed with Messrs. Drake and Gorham, of London, who are to put in about 300 lights.

Eastern Extension, Australasia, and China Telegraph Company.—The interest on the 4 per cent. mortgage debenture stock for the half-year ending January 31 will be paid by warrant on February 1. The stock register will be closed from 28th to 31st inst.

Taunton.—The Electric Lighting Committee reported to the Town Council on Tuesday that the Local Government Board had sanctioned the borrowing of £5,000 for purposes of electric lighting. The works in connection with No. 2 sub-station would be proceeded with at once.

Blackpool.—More arc lamps are being suggested for Claremont Ward. The attention of the Electric Lighting Committee has been called to the bad state of Bolton, Church, and Rawcliffe streets, South Shore, caused by the laying of the electric light mains in those thoroughfares.

Poyle Mills Company, Limited.—This Company has been registered with a capital of £2,000 to enter into an agreement for the acquisition of the business of a manufacturer of asbestos goods, now carried on by T. H. Ibbotson, under the style of the Poyle Mills Company, at Poyle, Middlesex.

Eton.—The scheme for applying for an order from the Board of Trade by the Windsor Corporation for the supply of electricity to Windsor and Eton, has been brought forward before the Eton Urban District Council, and the whole of the particulars were laid upon the table. The subject was postponed.

Supper.—The fourth annual supper of the employés of the Birmingham electric tramway route, Bristol-road, was held on Thursday last week at the Bournbrook Hotel. Mr. J. Booth, one of the directors of the Birmingham Central Tramway Company, presided over a gathering of nearly 100 employés.

Elmore Copper Companies.—These companies have been officially notified that their names have been placed upon the list of contractors to her Majesty's India Office for the supply of copper tubes, copper cylinders, and copper tape such as is used in the manufacture of cartridge-cases and for electrical purposes.

New Telephone Company.—An extraordinary general meeting of the New Telephone Company, Limited, held last week at the offices, London-wall, confirmed the resolution passed at the extraordinary general meeting held on the 19th ult. for winding up the the Company voluntarily. Mr. Albert Anns was appointed liquidator.

Lister Electric Light and Power Company.—Mr. W. J. Lister of Rivers Mills, Dursley, Gloucestershire, informs us that he has started, in addition to his own engineering and iron foundry trade, a branch business, the title of which is the Lister Electric Light and Power Manufacturing Company. The address is the same as above.

Bolton.—Alderman Miles, in proposing the minutes of the Gas and Electricity Committee, called attention to the fact that many persons had not replied to the circulars issued by the committee with reference to the supply of electricity, and intimated that every information as to cost, etc., might be obtained from the engineer.

Morecambe.—The Morecambe Electric Light and Power Company, Limited, have decided to remove their works from their present position in Edward-street to a site removed from the residential part of the town. It will be remembered that complaints have been made that the company's use of water gas constituted a nuisance.

St. Pancras.—The following have been elected members of the Electricity Committee: Messrs. Boden, H. Davies, Menzies, Prosser, Creed, C. H. Gittens, Thomson, Close, Cox, Guerrier, Parkes, Boulting, W. Smith, Williams, H. Cooper, Parkyn, Sweet, Hodgkinson, Ives, King, Catesby, Pettit, Rutter, Dean, Matthews, and Vickers.

Ripon.—The Mayor, Mr. Baynes, in referring to the subject of the gasworks, stated that in five years the whole debt on the capital account (originally £18,000) would be paid off. Then would be the time to go in for the electric light, unless there was such an improvement in the production of gas as to enable it to compete with the electric light.

Warminster.—The new Urban District Council has held a meeting at which the Clerk stated that the Local Government Board had declined to sanction the application for a loan for the electric light until the Council had obtained a license from the Board of Trade to produce electricity. It was then decided to take the necessary steps to obtain a license.

Worthing.—A meeting of the Town Council has been held, at which Alderman Cortis commented upon the action of the Highways Committee in encouraging experiments for the improvement of the street gas lighting, and urged the undesirability of spending money in this direction, if, in the near future, the Council were determined on having the electric light.

Larne.—The Town Commissioners received on Monday a letter from the electric company stating that the county surveyor obtained a decree at the Ballymena Quarter Sessions compelling them to remove the lamp-post at the corner of Inver and Bank roads. The receiver and manager of the electric company wrote requesting payment of the half-year's lighting account.

Maidstone.—A meeting has been held of the Urban District Council in connection with which Mr. Councillor Morling had given notice to move, "That this Council endeavour to dispose of the electric lighting order by tender, the conditions to be settled by the Electric Lighting Committee"; but as nearly all the members had left when the matter came up, he decided to defer the question till the next meeting.

Wells.—The Town Council on Monday had before them a letter from Messrs. Davies and Roach, agents of Mr. Brown, electrical engineer. They stated that they were in communication with the Board of Trade, who wrote that, while not declining to issue a license for electric lighting, they were prepared to grant a provisional order if applied for. The matter was deferred by the Council until the draft of the agreement with Mr. Brown for electric lighting is before them.

Smoke and Fumes Annihilator Company—This Company has been constituted with a capital of £120,000 in £5 shares to acquire the British patents of Mr. Samuel Elliott's invention, together with the trade marks and goodwill of the vendor relating to the sale of the disinfectant produced therefrom, and to manufacture, sell, and let on hire smoke annihilators, etc. The number of shares offered to the public is 18,000, the list of applications opening on Saturday and closing on or before Tuesday next.

Leicester.—The first place of worship in Leicester to adopt the new illuminant supplied by the Corporation from their gas and electric lighting department has been the Bishop-street Wesleyan Chapel, where an installation costing about £160 has been completed. Previously the chapel was lighted by 137 gas burners, and for these 134 16-c.p. incandescent electric lamps have been substituted. The work has been carried out by the Corporation, under the personal supervision of their engineer, Mr. Colson.

Hertford.—The following resolution has been passed by the Hertford Town Council: "That the requisite plans and specifications for the electric light installation in Hertford, prepared by Mr. J. A. McMullen, M.I.E.E., be laid before the Brush Electrical Engineering Company, in order that this company may tender for carrying out the same, with a view to the said company working the installation for a period and upon terms to be agreed upon between the Corporation and the said company."

Llanelly.—The new Town Hall and the new market hall at Llanelly will be shortly approaching completion, and one of the last things done by the old Local Board was to instruct the surveyor to report upon the probable cost of introducing the electric light to take the place of gas. The surveyor has reported that unless some of the tradesmen in the town also agree to go in for the new illuminant, a scheme for its introduction could not be carried out. Circulars have now been addressed to the principal tradesmen asking them whether they are prepared to adopt the change.

The Electrophone, Limited.—This Company has been formed, with a capital of £20,000 in 4,000 shares of £5 each, to take over and develop the business of the Electrophone Syndicate, which has for the past two years obtained patents, contracts, and concessions. The purchase price of the property, etc., for the whole of the United Kingdom has been fixed by the contract between the vendors and the Company at £15,000, payable as to £7,750 in fully-paid shares of the Company, as to £2,250 in cash, and the balance in cash or shares at the option of the directors, so that £5,000 will be available for working capital.

Belfast.—Alderman Pirrie, at a meeting of the Town Council, moved the adoption of the Electric Committee's report, which stated that considerable progress had been made with the central station and street works, and the committee anticipated being in a position to supply the electric light in the present month. Alderman Pirrie said that he felt great pleasure in announcing that they hoped during this month to have the electric light at the disposal of those who requested it. Considering that the committee was only appointed that day 12 months, and that they had now practically completed the works, he thought the result was very satisfactory. The report was adopted.

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City.—At this week's meeting of the City Commission of Sewers Mr. Johnson asked if the Streets Committee had considered the question as to the possible reduction in the cost of the public lighting of the streets. Mr. Burmester replied that certain experiments were being made in a system differing from the arc lighting, and the members hoped they might prove successful and prove better than the present system. Mr. Johnson asked if it was true that there would be a probable reduction of one or two thousand pounds a year. Mr. Burmester said he did not know whether that was so or not.—The electric light at Skinners' Hall, Dowgate-hill, has been installed by Messrs. Rashleigh Phipps and Co.

Long-Distance Telephony.—A meeting has been held of the Luton Chamber of Commerce, at which the President said their application in regard to telephonic communication with London they had every reason to believe had received proper attention If the Government simply took over the trunk lines connecting Liverpool, Manchester, Birmingham, and Hull with London, and left the rest of the country out in the cold, he did not know where they would be. He thought it was very probable they would have an opportunity shortly of speaking with their friends in London as much as other large centres had. Mr. Smith said the Government anticipated putting an exchange at Luton.

Windsor.—It is only a few months ago that the Windsor Electric Installation Company secured premises in High-street, and the services of Mr. E. A. Farrow as their manager, yet they have already completed a number of installations in the town and neighbourhood, and have also several large prospective contracts on hand. Their premises, at 48, High-street, are fitted up with a complete generating plant, consisting of a 6-h.p. Stockport gas-engine. driving a dynamo. Acting as a kind of central station, the Windsor Electric Installation Company has undertaken the lighting of the ground floor of Messrs. Caley and Son's establishment with 32-c.p. lamps. Other tradesmen have also adopted the light.

Electric Construction Company, Limited.—The staff and employés of this Company were entertained at dinner by Sir Daniel Cooper, Bart., G.C.M.G., chairman of the Company, in the Victoria Hotel, Wolverhampton, on Saturday last. Upwards of 120 gentlemen were present. The chair was occupied by Mr. James W. Barclay, in the unavoidable absence of Sir Daniel Cooper. After dinner, the following toasts were proposed and duly responded to: "The Queen and Royal Family," "Success to the Company," "Mr. Blackburn, the Staff, and Employés," "Sir Daniel Cooper, Bart," and "The Directors." During the evening, an address was presented to Mr. E. Garcke on the occasion of the expiry of his agreement as managing director of the Company.

Lambeth.—Mr. N. W. Hubbard, at the first meeting of the new Vestry, proposed the election of a Special Electric Lighting Committee. This might not be an opportune moment for installing the electric light, but at the same time he thought the Vestry should be put in possession of the latest information on the subject He was of opinion that the Vestry should not stand in the way of the users of the electric light. Mr. J. E. S. King seconded, as he believed the Vestry should be up to date in regard to the electric lighting system. Mr. Graves thought the matter was too important to be dealt with that night, and moved the adjournment of the question until next meeting. Mr. Victor Roger seconded the amendment, which Mr. Hubbard accepted, and the Vestry agreed.

Portsmouth.—The Electric Lighting Committee recommended that they be authorised to extend the electric light mains through Arundel-street (on one side), through Marmion-road (on both sides), as far as the Southsea Dairy Company's premises through Castle-road (on one side), and through Lake-road, and St. Mary's-road to the infectious diseases hospital; and that application be made to the Local Government Board for their sanction to borrow £3 056, the total estimated cost. This sum would, in fact, be part of the £20 000 which had already been sanctioned, but although an enquiry had been held as to this amount, a separate application was required as to each amount desired to be borrowed. After some discussion, the report of the committee was adopted.

Appointments Vacant.—The Technical Instruction Committee of the East Suffolk County Council invite applications for the office of organising secretary. Salary £200 per annum, and, in addition, actual travelling and out of pocket expenses. An office and a clerk are provided. Applications, stating qualifications, and enclosing copies of not more than three testimonials, to be sent to the secretary of the committee, Mr. D. T. Cowan, 26, Butter Market, Ipswich, by 11th inst. The appointment will be subject to confirmation by the County Council at the meeting in March. The candidate selected is required to enter upon his duties on February 1. Canvassing will be considered a disqualification.—An assistant electrical engineer is required at a salary of £120 by the Corporation of Sunderland.

Cardiff.—There are now about 30 private consumers of electricity in the town, and applications have been made for motors for trade purposes. The work of laying down cables up Park-place and Dumfries-place is being pushed forward as rapidly as possible, and it is anticipated that there will be a good many consumers in and between these two streets, where there is some good residential property Several of the occupiers have already wired their houses in readiness for the introduction of the new illuminant. Other extensions will be up Cathedral-road, the cables being conveyed from Tudor-road through Clare-street and Newport-road as far as Oakfield-street. These new works are for the benefit of private consumers only, and there is no intention at present of lighting the streets named with electricity.

Ulverston.—A report has been presented to the District Council by the Electric Lighting Committee, and, in moving the adoption of this, Councillor Hodgson said the committee, along with the representatives of the Local Boards of Grange and the Ulverston Rural Sanitary Authority, had had several interviews with the solicitors of the Windermere and District Electric Supply Company, who were applying to the Board of Trade for a provisional order, and he hoped and trusted they had come to some satisfactory terms with the company. Of course, while the negotiations were in progress, these terms could not fairly with advantage to either side be made public, but he might say they were perhaps quite as fair as they could possibly get. The motion was agreed to after some discussion.

Bath.—The Lighting Committee of the Bath Corporation invited Mr. F. H. Medhurst, B.Sc., M.I.E E., to confer with them last Monday, and to advise them with regard to their proper procedure in opposing the application of the Bath Electric Lighting Company for a provisional order. The Urban Sanitary Authority had already passed a resolution refusing its consent to the application of the company, but Mr. Medhurst was of the opinion that a purely negative policy would not be likely to avail with the Board of Trade, and he cited the decisions of the Board of Trade with regard to Newmarket and Bedford in support of his views. Finally, Mr. Medhurst's advice was adopted, and a resolution carried that his worship the Mayor be requested to call a special meeting of the Urban Sanitary Authority for Friday (to-day) in order to consider, and if thought fit to pass, a resolution that the Authority itself apply for an electric lighting provisional order at the earliest possible date.

Manchester.—A meeting has been held of the City Council, at which Mr. Alderman Gibson, in submitting the minutes of the Gas Committee, called attention to the suggestion of the Electric Light Sub-Committee that the town clerk, in consultation with a special sub-committee should take the requisite steps for increasing the borrowing powers of the Corporation for electric supply purposes to such an amount as may be found necessary to supply the increased demand for electric current. The amount that it was expected would be required was £100,000. The Council would remember that they first put down a plant for the supply of 20 000 16-c.p. lamps. It was thought that would last for two or three years. That, however, was soon taken up, and provision had since been made for a further 8,000 16-c.p. lamps, and the committee had to-day customers for 27,000 16-c.p. lamps, and the cry was "still they come." The proceedings were approved, and so also was a special resolution directing that the necessary steps be taken for borrowing £100,000.

Notting Hill.—The newly-elected Vestry of Kensington had under consideration last week a letter from Messrs. Romer and Haslam, solicitors for the Notting Hill Electric Lighting Company, Limited, pointing out with reference to the report of the Select Electric Lighting Committee which was before the Vestry on December 5, dealing with their application for the consent of the Vestry to the grant of a provisional order for an extension of the company's area in North Kensington, that the present rule of the Board of Trade dispenses with the requirement of the Act as regards the one month's notice referred to in the committee's report, and urging that the consent of the Vestry should be given to the grant of the order at their next meeting, as the company had to be in a position to prove such consent on the 15th inst. The Vestry consented to the granting by the Board of Trade of a provisional order to the company for the supply of electricity in that portion of the parish of St. Mary Abbott's, Kensington, situated north of the area comprised within the company's principal order of 1889, subject to the right being reserved to the Vestry to object to the granting of the said order should any variation to which the Vestry may take exception be made in the draft now approved by them.

Birkenhead.—In the minutes of the Finance Committee of the Town Council it was resolved that Mr. Shoolbred be requested to prepare and submit to the committee the complete working plans, etc., in connection with the erection of the central electrical generating station, and the establishment of the necessary works in regard to the installation in order that quantities might be taken out and tenders obtained. Alderman Rawcliffe said he hoped the Finance Committee would approve of his suggestion that the work be placed in the hands of a special committee, for a very large sum of money was about to be spent, and a large amount of detail gone into. While they were all very grateful to the Finance Committee for the excellent way they had attended to these matters, it would be far better to relieve the committee from any detailed work, and from the handling of so great an expenditure. Alderman Deakin assured Alderman Rawcliffe that he was of the same opinion, and the committee would also agree that they were not the body to be entrusted with the control of the working of the scheme. Whether it went under the control of the Gas and Water Committee, or a special committee, would be determined afterwards. The Mayor suggested the desirability of a meeting being arranged between the Gas and Water and Finance Committees—the committees from whom would probably be chosen the body for the purpose of having the scheme in hand. Alderman Rawcliffe said, as the Finance Committee was itself composed of the chairmen of the other committees, their undertaking the selection of such a committee would no doubt be agreed to by the Council. The subject closed with this understanding.

Steamship-Lighting.—The *Indian Engineer* states that some interesting experiments have lately been carried out on the R. S. Company's steamship "Scinde" with regard to the possi-

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bility of night running in the Sunderbunds by the aid of the electric search-light A large party of guests assembled on board to witness the trial-run of the plant, which consisted of a 25,000-c.p. projector worked by a vertical engine (Marshall's), and dynamo placed on the upper deck—off Koila Ghat. The search-light was shown on different vessels down the river with the long-distance lens on, and then put on the bank with the diverging lens which throws the light in a wide flat beam, the trial proving in every way satisfactory, and she left the next morning, making a most successful run to Naraingunge and back in 12 days. Although detained frequently at night on account of tides and fog, Captain Ainsley reported most favourably on the light as an aid to navigation at night; and as the "Scinde" has just made a second trip to Naraingunge in even shorter time with the light, under the command of Captain Elder, there is no doubt that in the near future we shall see most of the boats running through the Sunderbunds both by night and day, which will be a great advantage to the tea and jute traders. While lying at the jetties at Naraingunge the "Scinde" illuminated them to facilitate night working by large incandescent lamps hung over her sides in reflectors. The whole plant was supplied and erected by the Oriental Telephone and Electric Company, and Mr. Lester Betts, the manager of their Calcutta branch, who has had a large experience of search-light work on the China rivers, accompanied the steamer on her first trip.

Liverpool.—A new building has been erected by the Corporation at the corner of Roe-street. The basement will be used for the storing of fittings in connection with street lamps and as a workshop for lamp repairing. The ground floor has been utilised as an office for both the gas and the electric light department, while the upper floor is devoted entirely to the testing of gas-meters. The Liverpool City Council, on Wednesday, adopted, by 29 votes to 13, a recommendation of the Special Lighting Committee that the Council should offer to purchase from the Liverpool Electric Supply Company, Limited, the whole undertaking of the company as a going concern this year, instead of waiting until the period when the Corporation could compel the company to sell, at price, terms, and conditions, as may be agreed upon between the company and the committee, and failing such agreement, as may be settled by arbitration. The committee were authorised to take the necessary steps to carry out the objects of the resolution. Alderman Forwood said if arbitration were resorted to he would not be surprised if the company preferred a claim for £500,000, and he deprecated giving the committee what might be called a blank cheque. At the same meeting the Town Council authorised the Special Lighting Committee to take steps to ascertain the cost of a scheme for supplying all the public buildings and markets in the city with electric light from a generating station or stations to be established by the Corporation. The buildings proposed to be lighted are all within a radius of half a mile, and at the present time the Council have to pay in respect to those buildings nearly £4,000 a year for gas. The committee are to obtain estimates from the Liverpool Electric Supply Company, Limited.

The Copper Markets.—Messrs. Steadman, Crowther, and Co., in their annual metal report for 1894, say in regard to copper that the production was curtailed, presumably under the stress of low prices, and will be further reduced if the arrangement between the big American and European producers can be again brought into force. There seems more disposition to send refined copper only to this country, and the largest American mines will send their European supplies in this form in the future. Exports fell off very considerably in refined sorts to the Continent, and in copper sheets to India, but an equal quantity of yellow metal was taken. Although copper sheets were very cheap, being offered in July at £46 5s, yet the advantage to Indian buyers was nullified by the lowness in exchange. The heavy Birmingham trades were fairly active, especially in tubes. Competition was very severe, and the unfavourable balance-sheets of some of the large companies show the difficulty of finding profitable employment. Foreign makers offered copper wire cheaper than it could be produced in this country, but English-made brass wire still held its own. A renewal of heavy shipments from the States early in the year prevented any confidence being felt in the future of the metal. Notwithstanding that deliveries were good and stocks in the aggregate diminishing, copper did not respond to the statistical improvement. In the open market warrants were sold at £42. 17s. 6d. in January, and this proved to be the highest value throughout 1894. There was an almost continuous fall throughout the first half of the year. By June it had dropped to £37. 17s. 6d., the lowest recorded price excepting during the time following the collapse of the copper syndicate in March, 1889. Some improvement followed, but £38 was again accepted in July. The market then turned round on rumours of proposals for a renewal of the agreement for the restriction of output, and 50s. per ton was soon gained. There was a gradual improvement throughout August and September, until £41. 15s. was reached. In October and November some realisations took place, doubtless influenced by the disappointment following the passing of the American Tariff Bill, and little by little the market drooped until £39. 15s. was touched early in December, when then was a rebound to £41, and this was the value on the last day of the year.

Wednesbury.—A report of the General Purposes Committee, brought up at a recent meeting of the Town Council, contained a paragraph relating to the cessation recently, for a time, of the electric tramcar traffic between Wednesbury and Walsall, and stating that the town clerk called upon the company to carry out their statutory obligations, and informed them that the Corporation would not consent to a resumption of traffic by steam power. Alderman R. Williams urged that the Corporation ought to do all in their power to induce the tramway company to adopt electric trams for all parts of their system. He trusted that the Corporation would not lose sight of their power in this matter, and he believed the company would not object to a little pressure on the subject. Mr. Oldbury reminded the Council that the extended period over which the company were empowered to use steam would expire on the 15th inst. The temporary stoppage of the electric trams caused great inconvenience, and there would be still greater inconvenience if the steam trams were stopped, as probably they would be unless the Town Councils of Wednesbury and West Bromwich went to the Board of Trade and asked for a further extension of time. West Bromwich was thoroughly opposed to the electric system because of the pillars which were required, or that system would probably have been applied long since to all parts of the company's lines; and, looking forward to the time when they could take possession of the line from Handsworth to West Bromwich, were asking for an extension of the cable system to the latter place. But if such an extension were brought about, Wednesbury would suffer still greater inconvenience and loss, because numbers of people who at present visited the town on market days would find difficulties put in their way. He suggested that the town clerk should attend a Board of Trade enquiry as to the causes of the recent explosion, and express the views of the Council. The Mayor proposed a resolution to that effect, and spoke in favour of the electrical system as the best, at the same time expressing an opinion that the cable system, which the West Bromwich Corporation desired the Corporation to adopt, would be too costly for them to undertake. The pillars might be unsightly, but people got accustomed to them, and the annoyance was not so great as that caused by the constant rumbling of the wire on the cable system. Mr. Pritchard seconded the proposition, which was agreed to.

Collier Audible Telephone Syndicate, Limited.—From the observations of the official receiver and liquidator (Mr. S. Wheeler) issued under a winding-up order made in this case on July 19 last, it appears that the syndicate was registered on April 16, 1891, and was formed to purchase and further develop patent rights granted to Mr. Arthur Thomas Collier for an improved audible telephone; to take out foreign patents for the same; to acquire the new machinery and plant at the works, 38, Gray's-inn-road; and generally to carry on the business of a telephone and electrical manufacturing and supply company. The nominal capital of the syndicate was £9,000, divided into 90 ordinary shares of £100 each. The London and Colonial Finance Corporation, Limited, now in voluntary liquidation were the promoters of the syndicate The official receiver, after giving some further details, states that, immediately after allotment, the syndicate commenced operations, which appear, however, to have consisted almost exclusively of experimental works in connection with the vendor's inventions. These experiments very quickly absorbed the working capital, and it was found necessary almost at the outset to obtain financial assistance from the corporation in the shape of a loan for £300, which was subsequently increased to £750 Early in 1892 the directors appear to have had under consideration a scheme for the formation of a new company to take over the assets of the syndicate, and on August 10, 1892, the new company was registered under the title of the Collier-Marr Telephone and Electrical Manufacturing Company, Limited, and, under an agreement dated December 31 following, took over the whole of the assets of the syndicate as a going concern, the consideration being £50,000, payable as to £46,000 in shares and £4,000 in cash. For the purpose of carrying out the sale of the assets to the new company, the syndicate went into voluntary liquidation on October 17, 1892, and a liquidator was appointed. The statement of affairs of the syndicate, submitted by the voluntary liquidator, shows liabilities £645, of which £606 are unsecured, there being an estimated surplus after meeting the liabilities of the syndicate, subject to cost of liquidation, of £25,617. The official receiver, after giving some further information, observes that there are matters in connection with the conduct of the business of the syndicate, and of the voluntary liquidation, which require further investigation.

Leeds Tramways—A meeting of the Town Council has been held, at which, when the minutes of the Highways Committee came up for confirmation. Mr. Denton Houghton rose and said he was not going to complain of the amount that had been spent by the eight gentlemen who formed the Tramways Committee, and who had up to the present time spent £207, or £26 per member, in visiting various places on the subject of tramway traction, the recent expedition to Paris by Alderman Firth and the city engineer having cost 50 guineas. The tramways had been in the hands of the Corporation 11 months; the committee had been gallivanting all that time, and it was time the Council had a report from them. He fancied the committee had forgotten what they had seen on their visits. Mr. Battle suggested that each member of the deputations should submit his own report. If the report was to emanate from the city engineer alone, they might as well have sent him alone. He hoped they would not have a report of one system only. Alderman Firth, chairman of the Highways Committee, replied that the report, when it was printed, would not be the report of the city engineer. Each member would, of course, be at liberty to express his own individual opinion as to what he believed was the best system of haulage. The Council could not make a greater mistake than to press for the committee's report. The Council had everything to gain by delay and nothing whatever to lose. As an instance he might mention that one system of haulage had developed during the last six months more than it had developed in six years before.

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The minutes of the committee were adopted. In order that the provisions of the Borough Funds Act might be complied with, a meeting of property-owners and ratepayers was held on Tuesday in the Council-chamber at the Town Hall to consider the Corporation Tramways Bill, which is to be promoted during the coming session of Parliament. The Mayor (Alderman Gilston) was in the chair, and amongst those present were about a dozen members of the Council, some Corporation officials, and a few of the general public. The proceedings, which were purely formal, began with the reading of the notice summoning the meeting by the town clerk, who also briefly enumerated the provisions of the Bill, especially that empowering the Corporation to work the tramways. The Mayor proposed, "That this meeting of owners of property and ratepayers of the city of Leeds do consent to the promotion by the Council of the city in the next session of Parliament of the Bill now produced to the meeting, and intituled 'A Bill to empower the Mayor, aldermen, and citizens of the city of Leeds to construct additional tramways, and for other purposes.'" Alderman Firth, without comment, seconded the motion, which was agreed to *nem. con.* The meeting then terminated.

PROVISIONAL PATENTS, 1895.

JANUARY 1.

30. **Improvements in gear-wheels for electromotors and applicable to other purposes.** James Cardwell Quinn and Robert McDougall, Globe Works, Holland-street, Pendleton, Lancs.

42. **Improvements in and connected with telephonic apparatus as adapted to mining and other purposes.** Max Binswanger, 73, St. Stephen's-road, Upton Park, London.

52. **Improvements in electric lighting apparatus for railway cars.** William Biddle, 33, Chancery-lane, London.

56. **Improved electrical cut-out.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.) (Complete specification.)

57. **A method of ascertaining the difference of electric potential at a distant extremity of conductors.** John Hopkinson, 28, Southampton-buildings, Chancery-lane, London.

60. **An improvement in electric arc lamps.** Walter Stevens, 1, Old Serjeant's-inn, Chancery-lane, London.

65. **Improvements in dynamo brushes.** The London Electric Wire Company, Limited, and John Willey, Anchor Works, Playhouse-yard, Golden-lane, London.

82. **Improvements in and relating to electric winding mechanism for clocks.** Carolus Arnold, 45, Southampton-buildings, Chancery-lane, London.

JANUARY 2.

106. **Improvements in primary batteries.** Edward Moses Levetus, Hymen Levetus, and Walter Rowbotham, 47, Vittoria-street, Birmingham.

107. **Improvements in primary batteries.** Edward Moses Levetus, Hymen Levetus, and Walter Rowbotham, 47, Vittoria-street, Birmingham.

148. **Improved methods and apparatus for measuring electrical currents.** Oliver Blackburn Shallenberger, 28, Southampton-buildings, Chancery-lane, London.

157. **Improvements relating to telephone call stations with automatic charge or fee-receiving devices.** Christian Albert Jensen, 77, Chancery-lane, London. (Nicolai Jacobsen, Norway.) (Complete specification.)

JANUARY 3.

176. **Improvements in connection with arc lamps more particularly adapted for electric search-lights.** Frank Michael Lewis, 2, East-parade, Leeds.

178. **Improvements in the manufacture of shades and shade frames for oil, gas electric, and other lamps.** Henry Brittain and Samuel Henry Brittain, 263, Balsall Heath-road, Birmingham.

185. **Improvements in telephonic apparatus for simultaneous telegraphy and telephony on the same line wire.** George Henry Bassano, 23, Lodge-lane, Derby.

226. **Improvements in electric call and alarm apparatus.** Ernst Herz and Jean Pierre Hartfuss, 18, Buckingham-street, Strand, London.

JANUARY 4.

230. **An improved automatic cut-out for electric circuits.** William Kingsland, 139, Upper Mostyn-street, Llandudno.

231. **Improvements in primary batteries.** Edward Moses Levetus, Hymen Levetus, and Walter Rowbotham, 47, Vittoria-street, Birmingham.

238. **Improvements in fittings for electric lamps.** Archibald Denny and Alexander Campbell Cormack, 87, St. Vincent-street, Glasgow.

261. **An improved electric stamper battery for ore crushing.** Francis Hodge, 18, Fulham-place, Paddington, London. (Charles Evensen, New Zealand.)

281. **Improvements in and connected with telephones.** Hermann Oppenheimer, 55, Redcross-street, London.

285. **Improvements in holders for electric incandescent lamps.** Theophilus Coad, 37, Cursitor-street, Chancery-lane, London.

297. **Improvements in the electrolytic treatment of tin and its separation from alloys and mechanical mixtures.** Carl Frederick Claus, jun., and Herbert Selwood Sutton, 151, Strand, London.

298. **Improved means for supplying an electrical current and safety devices for use in combination therewith with electric tram and other cars or vehicles.** Jean Claret and Olivier Vuilleumier, 47, Lincoln's-inn-fields, London.

JANUARY 5.

348. **Improvements in rectifiers for electrical currents.** William Burrowes Close, 4, South-street, Finsbury, London. (Complete specification.)

351. **Improvements in electric arc lamps.** James Eglington Anderson Gwynne and Rankin Kennedy, 11, Furnival-street, Holborn, London.

357. **An improved street, road, or underground junction-box for electric conductors.** James Thomas Rossiter, 46, Lincoln's-inn fields, London.

358. **Improvements in electrodes for secondary batteries.** J. Wershoven, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1893.

15906. **Electrolytic apparatus.** Young. (Société Outhenin Chalandre Fils et Cie) (Second edition.)

23833. **Switches or relays for alternating currents, etc.** Aron.

24951. **Electrical measuring instruments.** Nalder and others.

1894.

496. **Heating or welding metals electrically.** Thompson. (Coffin.)

835. **Electrolytic apparatus, etc.** Hargreaves and Bird.

3101. **Dynamo-electric machines.** Sayers and others.

3291. **Electric arc lamps.** Money and Nash.

3863. **Electric arc lamp.** Jones.

21707. **Electric conductors of electric railways.** Slater. (Platt.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅝-2¾
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2⅜
—— 4½ Debenture Stock	100	111-114
Charing Cross and Strand	5	4½-5⅛
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	15-15½
—— 5 per cent. Debenture Stock	115	130-133
City and South London Railway, Consolidated Ordinary	100	43-45
—— 4 per cent. Debenture Stock	100	125-127
—— 5 per cent. Pref. Shares	10	13⅞-14½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	3-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	97-102
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1¼-1½
Elmore's French Company	2	1/16-3/16
Elmore's Wire Company	2	1¼-1⅝
Fowler-Waring Cables	5	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	8½-9½
—— Preference	—	12
House-to-House Company, Ordinary	5	2½-2⅝
—— 7 per cent. Preference	5	6½-7
India Rubber and Gutta Percha Works	10	25½-26½
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	—	7-7½
Liverpool Electric Supply, Ordinary	5	7 5/16-7 7/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8½-9
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	⅛-¼
Metropolitan Electric Supply	10	9½-10½
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	5½-5⅝
—— 6 per cent. Cum. First Pref.	10	16-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	5½-6½
—— 3½ per cent. Deb. Stock	100	103-106
Notting Hill Company	10	7½-7⅞
Oriental and Electric Company, £1 shares	1	11/16
—— £5 Shares	—	7-7½
—— £4½ shares	—	5⅛-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅞-8½
—— 7 per cent. Pref.	5	8½-9½
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7½-7⅞
Yorkshire House-to-House	4½	4⅛-4⅜

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NOTES.

New Book.—Messrs. Longmans, Green, and Co. will shortly publish a work on telephony by Mr. A. R. Bennett.

Gustave Trouve.—A short sketch of the work accomplished by M. Gustave Trouvé is given in *L'Athénés*, a new Paris journal published at 6, Rue des Ecuries-d'Artois.

Award.—The commission of the mechanical section of the French Academy of Sciences have awarded a prize of 2,000f. (£80) to Mr. Leblond for his work in connection with electricity.

Trade Review.—A trade review of the business done by electrical firms during 1894 is being published in a German contemporary. This seems a new departure for our friends in that country.

Danger of Coal Gas.—The danger of using coal gas as an illuminant has once more been exemplified, seven persons having been suffocated a few days ago by inhaling this kind of gas at Springburn, Glasgow.

Electric Lighting in Rangoon.—A meeting of the Public Works Sub-Committee of the Rangoon Municipality has been held, when it was resolved to recommend the General Committee to call for tenders for lighting the town by electricity.

Institution of Electrical Engineers.—A meeting of the Institution will be held on Thursday, 24th inst., when a paper will be read on "The Origin and Development of the Telephone Switchboard," by Mr. J. E. Kingsbury, associate.

Royal Society.—Papers on the following subjects were down for presentation yesterday (Thursday) afternoon: "The Latent Heat of Evaporation," by Mr. E. H. Griffiths; and "On Slow Changes in the Magnetic Permeability of Iron," by Mr. W. M. Mordey.

Society of Arts.—The second Cantor lecture on "The Arc Light," by Prof. Silvanus P. Thompson, D.Sc., F.R.S., will be delivered on Monday. It will deal with the optics of the arc, the temperature of crater and of peak, and the distribution of light and of invisible radiation.

Personal.—Lord Kelvin has accepted an invitation to be present at the annual dinner of the Wolverhampton Chamber of Commerce on the 30th inst.—Mr. W. J. Hope-Johnstone, who was clerk of works during the equipment of the Bedford station, has now been appointed electrical engineer.

Books Received.—We have received from Messrs. Whittaker and Co. "Steelworks Analysis," by Mr. J. O. Arnold, F.C.S. This forms one of "The Specialists' Series."—A copy of a new and revised edition of "Electrical Engineering," by Messrs. W. Slingo and A. Brooker, has reached us from Messrs. Longmans, Green, and Co.

Section Lining Code.—A useful code of section lining has been issued, at the price of 1s., by Mr. James P. Maginnis, A.M.I.C.E., M.I.M.E. The code is to serve as a guide to young draughtsmen and others, for indicating on drawings and tracings the various materials generally used in engineering construction where it is impossible to indicate the materials by the usual colours. A code of this kind should be fixed up in every drawing office.

The Pacific Cable.—A Reuter's cablegram from San Francisco, dated 13th inst., states that Mr. Hatch, Hawaiian Minister for Foreign Affairs, arrived there that day from Honolulu, on his way to Washington. His object is to push forward the project for laying a telegraph cable from San Francisco to Honolulu. He declares that the Hawaiians dislike the idea of having foreign capital in the enterprise, and will only accept it as a last resort.

Manchester Literary and Philosophical Society. We have received a copy of the *Proceedings* of this society, containing a memoir by Mr. Henry Wilde, F.R.S., "On a Magnetometer for showing the Influence of Temperature on the Magnetisation of Iron and other Magnetic Substances." The *Proceedings* are issued from 36, George-street, Manchester.

Northern Society of Electrical Engineers.—The following new members and associates were elected at the meeting on Monday. Members: J. G. Calvert, Manchester; S. H. Casson, Manchester; M. Holroyd Smith, London; A. Stahl, Manchester; P. C. Pope, Burnley; A. H. Robinson, Liverpool; Wm. Lawrie, Prescot; G. B. Samuelson, London; F. C. Gibbons, Manchester. Associates: S. Hartford, R. Wood, and A. L. Lind—all of Manchester.

Institution of Mechanical Engineers. — The forty-eighth annual general meeting of this institution will be held at 25, Great George-street, Westminster, on Thursday evening, 31st inst., and Friday evening, February 1, when the following papers will be read: "The Determination of the Dryness of Steam," by Prof. W. Cawthorne Unwin, F.R.S.; and "Governing by Throttling and by Variable Expansion," by Captain H. Riall Sankey.

Cleaning of Commutators.—A new preparation, termed "Commudine," has been brought out as a preservative for the commutators of dynamos and the collectors of alternators. The London Electrical Goods Agency, of 53, Victoria-street, S.W., who have sent us a bottle of the preparation, state that it is the only article produced for the purpose, that it removes greasy oxide with the greatest facility, that it does not foul the brushes or damage the insulation between the commutator segments, and that it allows the commutator to develop a hard surface not liable to abrasion.

Municipalisation of Tramways.—The London County Council received on Tuesday the report of the Highways Committee, stating that the Board of Trade had signified their approval to the service of a notice upon the London Tramways Company requiring the company to sell to the Council the whole of the tramways, works, and undertaking authorised by the Metropolitan Street Tramways (Extension, etc.) Order, 1873, and the Pimlico, Peckham, and Greenwich Street Tramways (Extensions) Order, 1873, as confirmed by the Metropolitan Tramways Confirmation Acts, 1873.

Liverpool Engineering Society.—At the fortnightly meeting of this society held on Wednesday evening, the 9th inst., at the Royal Institution, the president, Prof. H. S. Hele-Shaw, M.I.C.E., in the chair, a paper was read by Mr. John A. Brodie, Wh.Sc., A.M.I.C.E., entitled "Tramways and Tramway Traction." The author, after a general *résumé* on tramways, dealt in detail with the question of permanent way, and then proceeded to discuss the relative merits of horse, locomotive, cable, and electric traction, and the comparative costs of these systems. A discussion upon the paper terminated the proceedings.

Transformer-Chambers.—The Board of Trade has addressed communications to the London County Council, the Wandsworth District Local Board of Works, and other local bodies which recently raised objections to the proposals of electric lighting companies to place transformer-chambers below the surface of the public thoroughfares. The letters, we are glad to say, are to the effect that the Board has adopted the advice given by Sir Courtenay Boyle, that, if proper precautions be adopted to secure the public safety, the Department would not be justified in forbidding the use of transformer-chambers in the way suggested.

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Sir Courtenay Boyle's remarks on the subject will be found in our issue of December 21, 1894.

Germany's Four Principles.—In the course of a review of technical development in the applications of electricity during 1894, the *Elektrotechnische Zeitschrift* states that the use of accumulators in central stations in Germany has greatly progressed. On the other hand, alternating-current stations have also been extended; and the four principles—moderate periodicity, large units, slower speed, and direct coupling—have fairly throughout been introduced in German works. Our contemporary submits that the rotary-current system bids fair to be adopted in new stations in preference to the ordinary alternating system.

Telephone Concert in Hungary.—The *Standard's* Vienna correspondent says that on Saturday last "an extraordinary concert and ball took place last night in the Hungarian town of Temesvar. The audience listened, by means of audible telephones distributed around the ball-room, to a military orchestra playing at the town of Arad, to duets and songs in Szegedin, to a chorus sung by a glee club at Szabadka, and to popular songs by celebrated artists in three different theatres at Budapest. The quartette at Arad was as distinctly heard as the 'Rakoczy March' that was telephoned from Szegedin. Finally, the young people present danced for hours to the music alternately played in all three towns and in Temesvar itself, outside the ballroom. It is believed that no such concert has ever taken place before in Europe."

Royal Meteorological Society. — The annual meeting of this society was held on Wednesday evening, the 16th inst., at the Institution of Civil Engineers, Great George-street, S.W.; Mr. R. Inwards, F.R.A.S., president, in the chair. The council, in their report, reviewed the work done by the society during the past year, and also stated that additional accommodation had been provided to meet the growing needs of the library. Forty-five new Fellows had been elected during the year. Mr. Inwards, in his presidential address, dealt with the subject of "Weather Fallacies," which he treated under the heads of saints' day fallacies, sun and moon fallacies, and those concerning animals and plants. He also referred to the almanac makers, weather prophets, and impostors who have from time to time furnished the world with fit materials for its credence or its ridicule. Mr. C. Harding then read a paper on "The Gale of December 21 and 22, 1894, over the British Isles."

Advantages of the American Patent System.—The *Scientific American* states that Mr. Edison has lately obtained several patents which have for years been pending in the Patent Office. One is for the manufacture of carbons, filed in 1880, fourteen years age. Another for dynamo regulator, filed in 1881, thirteen years ago. A third for plating metals, filed in 1884, ten years age. A fourth for carbon filaments, a fifth for electric distribution, both filed in 1886, eight years ago. In 1892 Mr. Edison also received four patents for telephones, the applications for which were filed in 1877, fifteen years before the issue of the patents. Continuing, our contemporary says: "It is evident there is something wrong in the law which thus facilitates and apparently encourages these unconscionable delays. Preliminary litigations, it appears, may be carried on for half a generation before the Patent Office prior to the grant of a patent. And, then, after the issue of the patent, battles in the courts are begun to settle the validity of the grant."

Electrolysis of Copper Sulphate.—An abstract is given in the *Journal* of the Chemical Society of a communication made by Mr. A. Chassy to the *Comptes Rendus* on this subject. The author states that when a hot solution of copper sulphate is electrolysed a remarkable violet-red deposit is usually obtained. With platinum electrodes and a current of 00·1 ampere per square centimetre an almost neutral saturated solution of pure copper sulphate at 100deg. yields a bright-red deposit of microscopic crystals derived from the cube and octahedron. These crystals consist of cuprous oxide. Below 100deg. the cuprous oxide becomes mixed with crystals of copper, the proportion of which is higher the lower the temperature. A similar effect is produced by increasing the strength of the current or diluting the solution. If the positive electrode consists of copper, its loss of weight is always distinctly lower than the gain in weight of the negative electrode. Moreover, if the voltameter containing the hot solution is connected in the same series with a voltameter containing a cold solution, the weight of the deposit in the former is always much greater than would correspond with the oxidation of the copper deposited in the latter.

Electric Lighting in Germany.—The Dortmund Municipality have had under their consideration the question of erecting a central electric light station. A favourable offer was received from the Allgemeine Elektricitäts-Gesellschaft, but the authorities have decided to establish a station on their own account.—Messrs. Kramer and Co., of Berlin, propose to establish a central station in the Upper Silesian iron-smelting district, intending not only to supply current therefrom for lighting and power purposes to various places in the district, but also to work several electric tramway lines.—A central electric light station is to be established at Hechingen.—Plans are being prepared for a central station at Warnsdorf which will not only supply current to the whole of the town, but also to the neighbouring villages of Niedergrund and Obergrund and the town of St. Georgenthal. The station will also be used in connection with a new electric tramway.—At Heilbronn, the electric light station, which is operated by turbines, has had to shut down owing to the amount of ice in the Neckar.—Messrs. Teumer and Kreyfeldt, who propose to establish a central station at Hirschberg, have issued circulars in order to ascertain the probable demand for current.

The Walker-Wilkins Battery.—In another part of the present issue will be found a report on this battery, which is being introduced by the Patent Non-Polarising Voltaic Battery Company, of Spring Hill Wharf, Birmingham. In the course of a letter to us the company state: "The novelty of the cell is that it depends upon the atmosphere as its depolarising agent instead of costly chemicals. By the action of the battery, nascent hydrogen occurs on the surface of the carbon constituting the negative element, and meeting with the condensed air in the pores of the carbon, combines with the oxygen of the same, the supply of air passing through the perforations. The hydrogen thus never assumes a gaseous form, and polarisation is prevented. The life of the electrolyte is remarkable, as will be seen from Prof. Jamieson's report. Its cost is very low—viz., 8d. per gallon—and in the three-cell oval type the quantity of solution is under three quarts, and its cost is therefore 6d. — giving 768 ampere-hours. Sufficient height of porous cell is allowed for feeding purposes; cells require feeding once per week. The oxide is recovered from the exhausted solution with the greatest ease, solution resuscitated and used again from time to time with a percentage of loss in treatment."

Dynamos and Coupled Plants.—A well illustrated machine catalogue, dealing with dynamos, motors, and direct-coupled plants, has been issued by Messrs. Laing, Wharton, and Down, of 82A, New Bond-street, W. One

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of the most noticeable features of the illustrations is the application of electric power. Thus, for instance, the frontispiece shows a factory, or the machinery and tools contained in it, driven by a large "L. W. D." type of motor. Then, again, a view is given of a 100-h.p. dynamo installed for the transmission of power, and another illustration showing the motor to which the current is conveyed. In the list of dynamos two tables are given showing the relation of speed to output, which apply equally to the capacity of the motors at various speeds. One of the main features of these generators is the provision of an alternative winding, by means of which and the changing of a switch a compound machine can be used for charging accumulators. Various types of dynamos, including arc, incandescent, and plating and depositing machines, are shown—one generator being coupled direct to a turbine and another to a vertical engine. The coupled plants are specially intended for shiplighting, factories, and central stations, where room is a consideration.

Electric Heating of a Theatre.—The lessees of the Vaudeville Theatre found it necessary during the recent severe weather to provide some system of warming the theatre. Mr. Henderson, the manager, after having considered several systems of heating by hot water, steam, etc., decided to adopt electric heating on account of the many advantages of the system. Messrs. Crompton and Co., of Brompton-road, were thereupon called on to supply at once electric heating apparatus suitable for carrying out the work. The order was received at 11 o'clock on Tuesday morning, and by six in the evening the theatre was being warmed electrically. Although no mention had been made in the theatre of any system of heating having been adopted, many persons remarked on the increased warmth and comfort. The large radiators used were perfectly portable, and, owing to this fact, it was found possible to place them in the stalls during the day, and remove them to the sides of the theatre in the evening. We are glad to learn that Messrs. Crompton and Co. have now received the order for the permanent warming of the theatre, and in a short time it is expected the new system will be completed. The cost is not expected to exceed that of other systems, and this, combined with the advantage of freedom from danger, with perfect regulation, should make electric heating very popular for the warming of theatres.

Electric Traction in Germany.—The project for an electric railway between Stralau and Treptow Park, Berlin, passing by a tunnel under the Spree, has been approved by the authorities concerned.—An electric tramway is projected between Elberfeld, Hahnerberg, and Hasten.—At Dresden the local authorities have sanctioned the adoption of electric traction on the four lines of the Dresden Street Tramway Company and of the German Street Tramway Company. The new system will come into operation in October. Current will be obtained from the municipal central electric light station.—The electric tramway through Marienthal, with a branch to the Wartburg, to which we have already referred, is to be carried out jointly by Messrs. Bachstein, railway engineers, and the Allgemeine Elektricitäts-Gesellschaft, of Berlin.—Authority has been given for the construction of a suspended railway on the Langen system at Hamburg. Both banks of the Elbe will be connected by it by means of a high-level bridge.—An electric tramway has been opened this month at Hagen, Westphalia, copper-zinc accumulators being employed. This is the first line of the kind in Germany. The work has been carried out by the Hagen Accumulator Works. Four cars are in use. They are of the ordinary size, carrying 26 passengers. Under each of the two seats there is a wooden battery trough carrying 44 copper zinc cells, or 88 in all. The motor is of 15 h.p.

Electrical Conductivity of Organic Salts.—Mr. A. Bartoli, in the *Gazzetta*, deals with the dependency of the electrical conductivity of organic salts on the temperature. The paper describes the result of a continuation of the author's investigations of the electrical conductivity of organic substances; he draws the following conclusions from a study of about 60 aliphatic salts. At ordinary temperatures, or at the boiling points, the electrical conductivities of aliphatic alkylic salts of small molecular weight are greater than those of their higher homologues. The electrical conductivity of such salts increases with the temperature, the coefficient of increase of conductivity being greater for salts of high molecular weight than for their lower homologues; the temperature coefficient of the conductivity therefore increases as the viscosity of the salt increases. In the one or two cases in which the conductivity decreases with rise of temperature, the anomalous behaviour can be explained by assuming the presence of a trace of an aliphatic alcohol. The conductivity of a salt may be caused to decrease with rise of temperature by adding from 1 to 20 per cent. of any aliphatic alcohol; the electrical conductivity of a salt still increases as the temperature is raised on adding to it aniline, paraldehyde, a phenol, a ketone, or an acid.

Electro-Harmonic Society.—A smoking concert will be held on Friday, January 25, 1895, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at eight o'clock. The artistes will be the Dilettante Vocal Quartette, Mr. James Brown, Mr. Frederick Bevan, Mr. Edward Dalzell, and Mr. Robert Hilton; solo bassoon, Mr. E. F. James; solo pianist, Mr. Alfred E. Izard. Musical sketches will be given by Mr. George Pritchard. The musical directors are Messrs. T. E. Gatehouse and Alfred E. Izard. Programme—Part I.: glee, "Sigh no More, Ladies" (R. J. S. Stevens), the Dilettante Vocal Quartette; new song, "The Mighty River" (F. Bevan), Mr. Frederick Bevan; pianoforte solo, "Caprice" (Schumann), Mr. Alfred E. Izard; aria, "Where'er You Walk" (Handel), Mr. Edward Dalzell; musical sketch, Mr. George Pritchard; song, "Still is the Night" (Franz Abt), Mr. Robert Hilton; bassoon solo, "Variations and Rondo" (Kalliwoda), Mr. E. F. James; humorous part song, "Simple Simon" (specially arranged), the Dilettante Vocal Quartette. Part II.: part song, "Thinking of Home" (Millard), the Dilettante Vocal Quartette; new song, "The Old Soldier" (F. Bevan), Mr. Frederick Bevan; bassoon solo, "The Lowly Youth" (J. H. Young), Mr. E. F. James; song, "An Evening Song" (Blumenthal), Mr. Edward Dalzell; musical sketch, Mr. George Pritchard; song, "My Lodging is the Cellar" (D'Alquen), Mr. Robert Hilton; glee, "Amo, Amas" (Shield), the Dilettante Vocal Quartette.

Electric Traction in France.—It is proposed to extend the Bordeaux-Bouscat-Vigean electric tramway to the Quay Louis XVIII.—The electric tramway at Dijon will shortly be opened for public traffic. Trials which have been made have proved very successful.—An interview has taken place between the mayor of Lille and the management of the new tramway company, at which the former represented inhabitants who objected to posts carrying the trolley wires being placed opposite their houses. It was explained that agents of the company had been instructed to obtain permission from house owners for wall brackets to be fixed, and poles had only been erected where such permission had not been obtained. It is expected that the line will be opened by the end of the month. It would appear

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from a report published in a local paper that very friendly rivalry exists between French promoters of systems of electric traction for Toulon. No less than 12 companies sent in to the tramway company schemes for converting their lines from horse haulage to electric traction, and the company have now decided in favour of the trolley system. It is intended to place on the lines 30 cars, each equipped with two motors of 15 h.p.—It is intended to construct three lines of electric tramways at Le Mans, the first from the railway station to the end of the Rue des Maillets, the second from the hospital to the octroi depot on the Paris road, and the third from the Place de la Croix d'Or to the Place de la Lune. The Municipality will apply to the State for the necessary concessions, and then pass them over to Mr. E. Faye, who has the concession for the Dijon electric tramway.—Mr. Roy is promoting a scheme for an electric tramway to connect the old town of Lourdes with the newer quarters.

Municipal Electricity Works.—Some discussion having taken place in German papers and at meetings of some town councils as to the commercial position of municipal electricity works, Mr. Max Meyer, of Nurnberg, thinks it advisable to give some information on the subject. He has accordingly availed himself of the columns of the *Elektrotechnische Zeitschrift* of the 10th inst. for discussing the matter. The author states from the official reports published of the working of German stations that the anticipated surplus of income over expenditure has in most cases been realised. In those towns where gasworks exist the connections to the electric light mains are somewhat slow during the first year, particularly when the price of electrical energy is high. Consequently a proper conclusion cannot be drawn from the initial year's operations, but the connections increase as the electric light undertaking gives satisfaction to its customers. As an instance of this, the author gives a comparative table showing the growing increase in different towns from 1889 to December, 1894. A second table is given concerning the working results of the same and other stations. This table, an abstract of which is given below, represents, in percentage of the capital outlay, the surplus of receipts over expenditure during 1893-94, this balance remaining for the payment of interest and redemption. The figure of 4 per cent., as in the case of the Christiania electricity works during the year 1893-96, the author states, is sufficient for providing for depreciation.

	Receipts.	Expenditure.	Surplus.
Altona	12·6	5·56	7·04
Barmen	11·7	4·10	7·60
Breslau	23·98	9·02	14 96
Cassel	13·1	4·1	9·0
Christiania	13·1	4·90	8·20
Dusseldorf	9·92	2·94	6·98
Elberfeld	14·1	6·2	7·90
Neuhaldensleben	19·4	8·2	11·2

A direct proof of the commercial success of central stations, the author concludes, is afforded by the energetic endeavours on the part of promoters to obtain fresh concessions and to carry out electric lighting works at their own expense.

The Arc Lamp.—The first of three Cantor lectures on this subject was delivered on Monday evening by Prof. Silvanus P. Thompson before the Society of Arts. The lecturer, after remarking that much about the electric arc is still very obscure, discussed the question when and by whom it was first observed, and came to the conclusion that, in the first year or two of this century, Davy and other investigators found they could get sparks visible in daylight between well-burnt charcoal points connected each with a pole of the newly-discovered voltaic pile. These early experimenters did not clearly discriminate between a continuous arc and a succession of sparks, but in 1808 this distinction was certainly known. In 1820 the hard carbon deposited in gas-retorts came into use, and in 1846 the first mechanical arc lamp was devised. The lecturer then exhibited the arcs formed between various metals, and pointed out their different characteristics. He afterwards confined his remarks almost entirely to the arc produced between carbon conductors, carbon being the only material as yet known that is suitable for the industrial production of the electric light. He then proceeded to consider the physics of the arc. He discussed the conditions necessary for its formation, the point from which the greatest light is emitted, the relations between E.M.F. and length of arc and between amount of current and size of arc, the temperature of the crater, the fall of potential in the arc, and the question of the transfer of material from one carbon to the other, concluding, with regard to the last point, that material is transferred in one direction only—from crater to peak. He then showed an arc formed by an alternating current of 2,000 volts, though this, he said, was not a true arc, but of the nature of a flame. In the true arc there is combustion of the air with the production of carbon monoxide and dioxide, and of various nitrous compounds, whose smell may sometimes be noticed. In conclusion, Prof. Thompson referred to Duncan's researches into the effects on the arc of variations in the pressure of the air in which it is burning. As a rule, the temperature is raised by increase of pressure, and a higher E.M.F. is rendered necessary.

New Mains.—The London County Council have been impressed with the recent explosion in the Euston-road. The Westminster Electric Supply Corporation have given notice of their intention to lay mains across Norfolk-street and on both sides of Wood's-mews, Park-lane, in Palace-street and across it in two places, and across Stafford-place and across Francis-street in five places, and along the south side of it from Howick-place to Vauxhall Bridge-road. The proposed works are of the usual description, but the Highway Committee of the London County Council think that, having regard to the evidence brought forward at the enquiry into the cause of the recent explosion in connection with the electric lighting of the Euston-road, a condition that adequate ventilation shall be provided for the street boxes should be attached to the Council's consent. They accordingly recommended that the sanction of the Council be given to the works referred to on condition that the details of the street boxes to be used, showing adequate provision for ventilating them, be submitted to and approved by their engineer before the work is commenced, and that the covers of the boxes consist of iron frames filled in with materials to suit the paving. The House-to-House Electric Supply Company gave notice of intention to lay high-tension mains in Longridge-road. It has been stipulated that no pipes of a larger diameter than 6in. be used; that no street boxes be constructed until full details shall have been submitted to and approved by the Council's chief engineer; and that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes be provided with an inner cover sheathed with wood or other non-conducting material, as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover be efficiently connected to earth. The same company intend to construct two transformer-boxes in Collingham-gardens and one in Barkston-gardens. The Charing Cross and Strand Electricity Supply Corporation intend to lay mains on the north side of the Strand, from the south-east corner of Trafalgar-square to the corner of Duncannon-street. It has been provided by the Council that the concrete floors

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of the street boxes be 9in. thick and the York stone at the top 4in. thick, and that the longtitudinal girders (if used) in all the boxes be laid on 3in. stone templates the full thickness of the brickwork, which shall be 9in. thick. The Kensington and Knightsbridge Electric Lighting Company propose to lay mains and construct street boxes in Ovington-gardens and Ovington-mews.

Treatment After Electrical Shock.—The French Academy of Medicine having been asked by the Ministry of Public Works to draw up a set of rules for the treatment of those who may receive electrical shocks, a committee was appointed consisting of Messrs. Bouchard, d'Arsonval, Laborde, and Gariel. They have prepared the following statement: When a person is the victim of an accident due to contact with the electrical conductors or with the generators, the contact may exist when help arrives, or it may have ceased. In the former case, special precautions should be taken to break the contact without those helping becoming themselves victims. It is best to immediately stop the generating dynamo from working. If this be impossible, the current should be broken by cutting the conductor with instruments in which the cutting part is insulated from the handle, or the current is taken to earth or a branch by means of a conductor of low resistance, which will diminish the intensity of the current in the part where the victim is in contact with the principal conductor. These observations are merely made as a guide, and are to be formulated by a special technical commission instituted by the Ministry of Public Works. The following measures are proposed: The victim is to be first of all taken into an airy place; three or four persons should be there to assist, and no one else allowed to enter. The clothing is to be loosened, and efforts to be made to re-establish respiration and circulation as soon as possible. To re-establish respiration, recourse can be had to the following two methods—viz., drawing of the tongue and artificial respiration. In the former case the mouth of the victim is opened, and if the teeth are clenched they are to be opened with the fingers, or, if there be resistance, with a piece of wood, the handle of a knife, spoon, or fork, or end of a walking-stick. The front part of the tongue should then be taken between the thumb and index finger of the right hand, bare, or covered with, say, a pocket handkerchief (to prevent slipping). The tongue is then strongly pulled, and allowed to relax, in rhythmical imitation of respiration, at least 20 times a minute. These movements must be continued without a break for half an hour, an hour, or more. For artificial respiration, the subject should be laid on his back, the shoulders slightly raised, the mouth open, and the tongue free. The arms are taken at the height of the elbows, supporting them strongly on the walls of the chest, next bringing them above the head, describing the arc of a circle. These movements are to be continued at least 20 times a minute until the re-establishment of natural respiration. It is suitable to commence with the movement of the tongue as described, simultaneously, if possible, adopting artificial respiration. At the same time it is desirable to try and restore circulation by rubbing the surface of the body, by beating the body with the hands or with wet towels, throwing cold water on the subject from time to time, and applying ammonia or vinegar to the nose.

Telegraphy in Africa.—The report of the directors of the British South Africa Company, which has just been issued, contains the following information with respect to African telegraphy. In connection with the Matabele campaign a light field telegraph was erected by the Government between Palapye and Tati, a distance of 89½ miles. An office was opened at the latter place on January 22, 1894, and very shortly afterwards the line was handed over to the British South Africa Company, by whom it was extended to Ramaquaban, a distance of 17½ miles in a northward direction, where a temporary office was established on March 13, 1894. From thence a wooden pole line of a more permanent character was constructed, *vid* Mangwe, to Buluwayo, 105 miles, at which latter place an office was opened on July 9 last. The cost of this 105 miles did not exceed £30 per mile. It has been arranged that, in return for a payment of £1,000 a year, her Majesty's Government has the use of the wire for official messages to and from the company's offices in Matabeleland and Mashonaland. The lines between Tati and Mangwe, and between Mangwe and Buluwayo, were erected under the superintendence of the Cape Postal Department, and it has been decided, with the approval of the Government of that colony, that the Cape Postal Department shall, for purposes of common advantage, control the working of the company's service in connection with their own. Upon the line reaching Buluwayo, it was immediately decided to push forward the extension to Charter (*vid* the township of Gwelo), a further distance of 212 miles, and thus place Buluwayo in direct communication with Salisbury. It is anticipated that this branch will be opened for traffic before the close of the present month of January. In order to strengthen the chain of telegraphic communication northward, it has been decided to erect a short alternative iron pole line from Macloutsie to Mangwe, about 112 miles; this line is now in course of construction. A line will also be carried from Salisbury *vid* Umtali to Chimoio, the Beira Railway terminus, a distance of about 215 miles, thus placing Cape Town, Buluwayo, and Salisbury in communication with Beira. The total number of miles of telegraphs (exclusive of railway service lines) worked and owned by the British South Africa Company south of the Zambesi is now 1,225, and on the completion of the proposed extensions it will represent a mileage of 1,551. The revenue of the company's telegraph department, which, owing to the disturbances caused by the late Matabele war, only showed a net return for the 12 months ended March 31, 1894, of £370. 7s. 6d., now shows, after the pacification of the country, a net revenue of £2,755. 2s. 3d. for the six months ended September 30, 1894. It is interesting to note that during the month of October last, the gross revenue derived from the Buluwayo telegraph office was £526. 17s. 1d., showing the rapid growth and development of that town. Since the date of the last report good progress has been made with the work of construction by the African Transcontinental Telegraph Company, Limited, of that section of the line to Uganda which is to connect Salisbury in Mashonaland with the company's possessions north of the Zambesi, bringing Nyassaland, British Central Africa, and ultimately Lake Tanganyika, in direct communication with the Cape, and thereby Great Britain. The survey of the section from Salisbury to Zomba (400 miles) has long since been made; the material for the sub-divisions north and south of the Zambesi has been sent forward, and about 313 miles of line have been completed. This includes the section of 180 miles from Blantyre to Tete, and that northward from Salisbury as far as the Mazoe River, where telegraph offices have already been opened. An arrangement has been arrived at by the British South Africa Company, on behalf of the African Transcontinental Telegraph Company, with the Portuguese Government for the construction by them, with the telegraph company's material, of that part of the line, covering about 120 miles, which crosses Portuguese territory.

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THE DESIGN AND EFFICIENCY OF PLANT FOR THE TRANSMISSION OF POWER BY ELECTRICITY.

A paper on this subject by Mr. W. C. Mountain, member of council, was read on Tuesday before the North-East Coast Institution of Engineers and Shipbuilders. The author first described the various units used by electrical engineers, and then detailed the construction and working of the dynamo and electric motor, this being followed by a table of the sizes, sectional areas, carrying capacity, etc., of cables. The author then proceeded as follows:

In laying down a transmission of power or lighting plant it is necessary to consider the loss of watts and volts in a cable, as it is very often necessary to proportion the size of the cable so that a certain number of watts or volts are lost, and the following rules will be of service:

Rules to Find the Loss in Volts in a Cable.—The volts lost in a cable of any length may be found by multiplying the resistance of the cable by the current flowing. It must of course be remembered in making this calculation that the distance between the dynamo and motor is doubled in the cable on account of the return conductor. If, therefore, the motor is half a mile from the dynamo, the total length of cable will be one mile.

Example.—To find the loss of volts in a $^{7}/_{15}$ cable—that is, a cable composed of seven wires, No. 15 L.S.G.—one mile in length, with a current of 29 amperes—*i.e.*, approximately 1,000 amperes per square inch section of copper—resistance of one mile of $^{7}/_{15}$ cable equals 1·498 ohms

$$1{\cdot}498 \times 29 \text{ amperes} = 43{\cdot}442 \text{ volts lost.}$$

It may be taken as a general rule (sufficiently accurate for ordinary practice) that there is a loss approximately of 2½ volts per 100 yards in cables where the current density is 1,000 amperes per square inch section of copper.

Rule to Find Loss in Watts or Volt-amperes in a Cable.—A further rule which will be of service in calculating the watts lost in any length of cable is the following: first, square the current—*i.e.*, multiply the current flowing in amperes by itself—and then multiply by the resistance, which will give the watts lost in the cable. For instance:

Example.—To find the watts lost in a $^{7}/_{15}$ cable when carrying a current of 29 amperes.

$$29 \times 29 \text{ amperes} \times 1{\cdot}498 \text{ ohms} = 1{,}259{\cdot}811 \text{ watts lost.}$$

It is therefore necessary, in estimating the size of generator required to drive a motor, to add to the actual watts required at the motor terminals the watts lost in the cables, and also the generator must be constructed to give at its terminals an E.M.F. equal to the volts lost in the cables, plus the volts required at the terminals of the motor. By suitably proportioning the size of cable to the work to be done, it is possible to make the power consumed in the cables anything that may be desired, but it must be borne in mind that by unreasonably increasing the size of the cable, and thus reducing the loss, a point is soon reached by which the first cost of the cable will be so high that the saving will not be economical.

Class of Cables.

There are, of course, many descriptions of cables suitable for transmission of power work—*i.e.*, as regards the insulating substance—but the writer does not recommend that any cable should be used with an insulation resistance of less than 300 megohms per statute mile. This is a suitable insulation for all voltages up to, say, 200; exceeding 200 and up to 600 the insulation resistance of the cables should be not less than 600 megohms per statute mile; and for a higher voltage, particularly if there is any damp, the insulation resistance should not be less than 2,000 megohms per statute mile. A megohm, it may be here mentioned, is the resistance equal to one million ohms, and the resistance of a cable is usually taken by immersing it in salt water for 24 hours, and then taking the insulation resistance between the conductor and the earth.

Various classes of insulating materials are used for the insulation of cables as under: (1) pure indiarubber, (2) vulcanised indiarubber, (3) vulcanised bitumen, (4) bitumenised fibre, (5) paper. Other substances have been used with more or less success, but the above may be taken to fairly represent the standard substances in use.

For lightly insulated cables pure indiarubber is sometimes used, but for general work the writer does not recommend this class of insulation, and strongly advises that vulcanised indiarubber be adopted as the insulating medium. Bitumen is largely used for colliery work, but cables of this description are generally armoured with galvanised iron wire or steel tape, and the writer would not recommend the use of bitumenised-covered cables except a protection of this class is used. Cables insulated with bitumenised fibre are also largely used for transmission plants, and Mr. Siemens in his paper before the Mining Institute showed a class of cable of this description which he used throughout his works. Bitumenised fibre is necessarily a substance which would very quickly absorb damp, and may be described as a mechanical insulating material, as it will mechanically stand a considerable amount of knocking about, and is only a thoroughly good insulating material when dry; it has, therefore, to be protected by being drawn into lead pipe, and may be then either braided or compounded outside the lead, or, as is most usual, armoured with galvanised iron wire or steel tape. The paper insulation has practically the same properties as the bitumenised fibre, and must be protected with lead, and if liable to injury must be further protected by galvanised iron wire or steel tape.

If it is proposed to run the cables along the workshop in casing, or to secure them by cleats or support them on insulators, then cables insulated with vulcanised indiarubber, or even pure indiarubber in very dry places, can be successfully used; but if it is desired to lay the cables underground, then they should either be lead covered, or preferably lead covered and armoured. Where cables are liable to mechanical injury—*i.e.*, in an engine-shop or a colliery—it is advisable to have them further protected by galvanised iron wire or steel tape, and the cables are generally further protected by a thick covering of hemp coated with preservative compound. It is advisable also to run the cables in wood casing, the casing to be grooved and fitted with a cover.

Efficiency of Motors.

Before any general scheme can be laid down, and also before the output of the dynamo can be calculated, it is necessary to take the actual watts required at the motor terminals, and to add to this the watts lost in the cables themselves conveying the current from the dynamo to the motors, and the following table is given showing the approximate efficiencies of electrical motors of varying horse-powers, with the watts required at the terminals of the motors at the efficiencies given, to produce one effective horse-power on the motor shaft:

Effective horse-power of motor.	Commercial efficiency. Per cent.	Watts required at terminals.
50 and upwards	90	829
40 ,,	88	848
25 ,,	85	878
15 ,,	80	904
5 ,,	75	995
3 ,,	70	1,066
1 ,,	65	1,148
½ ,,	60	1,244
¼ ,,	55	1,357
⅛ ,,	50	1,492

As an example, let it be assumed that it is intended to drive a motor 440 yards away from the dynamo—*i.e.*, a quarter of a mile—and the motor is to give 25 effective horse-power, with an efficiency of 85 per cent., the formula there is 25 effective horse-power by 878 watts per horse-power = 21,950 watts at motor terminals. The voltage at which it is proposed to work at the motor must then be assumed, and in this case let it be taken at 300 volts. Dividing the total watts—viz., $\frac{21{,}950}{300} = 73{\cdot}16$ amperes required to feed the motor.

It will be found that a suitable cable, assuming a current density of 1,000 amperes per square inch, would be wanted composed of seven wires No. 11 L.S.G. with a resistance of ·5776 ohm per statute mile, the length of the cable being half a mile—*i.e.*, to the motor and back—it therefore follows that the resistance of these mains would be ·2888

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ohm. Taking the formula already given for finding the loss in watts in a cable—*i.e.*, multiplying the current by itself, or squaring it and multiplying by the resistance of the cable—it will be found that 73·16 amperes × 73·16 amperes × ·2888 ohm resistance = 1,546 watts lost. The

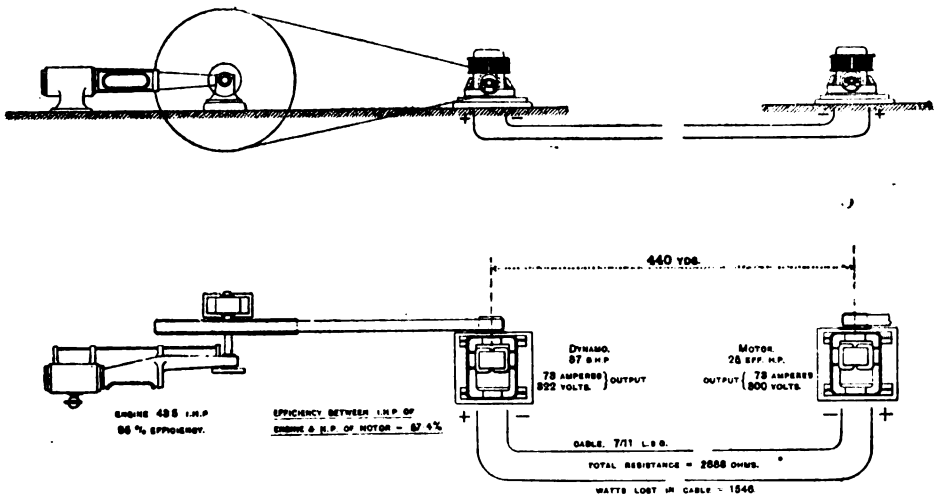

DIAGRAM I.

watts lost must now be added to the watts consumed by the motor, as under—viz. :

Watts consumed by motor	21,950
Watts lost in cables	1,546
Total	23,496

Therefore the generating dynamo must be capable of giving an output in watts equal to the above.

As the current was 73·16 amperes, all that is therefore necessary is to divide the watts required at the dynamo by the amperes, which gives the voltage at the dynamo terminals, say,

$$\text{Total watts } \frac{23,496}{73·16} = 322 \text{ volts at dynamo terminals.}$$

From the above it will be noted that the loss in the cables equals, say, 7 per cent. of the electrical output of the dynamo.

To find the total percentage of efficiency—*i.e.*, between the effective horse-power on the dynamo spindle and the effective horse-power given off at the motor spindle—the formula becomes, assuming an efficiency at the dynamo of 85 per cent., as under :

$$\frac{\text{Total watts of dynamo} = 23,496 \times 100}{746 \times 85} = 37 \text{ effective horse-power required to drive the dynamo.}$$

Assuming the efficiency of the engine driving the dynamo is 85 per cent.—*i.e.*, the difference between the indicated and the effective horse-power—the indicated horse-power of the engine will therefore be :

Effective horse-power required on dynamo spindle $\frac{37 \times 100}{85} = 43·5$ indicated horse-power to drive the dynamos.

Therefore the efficiency between the indicated horse-

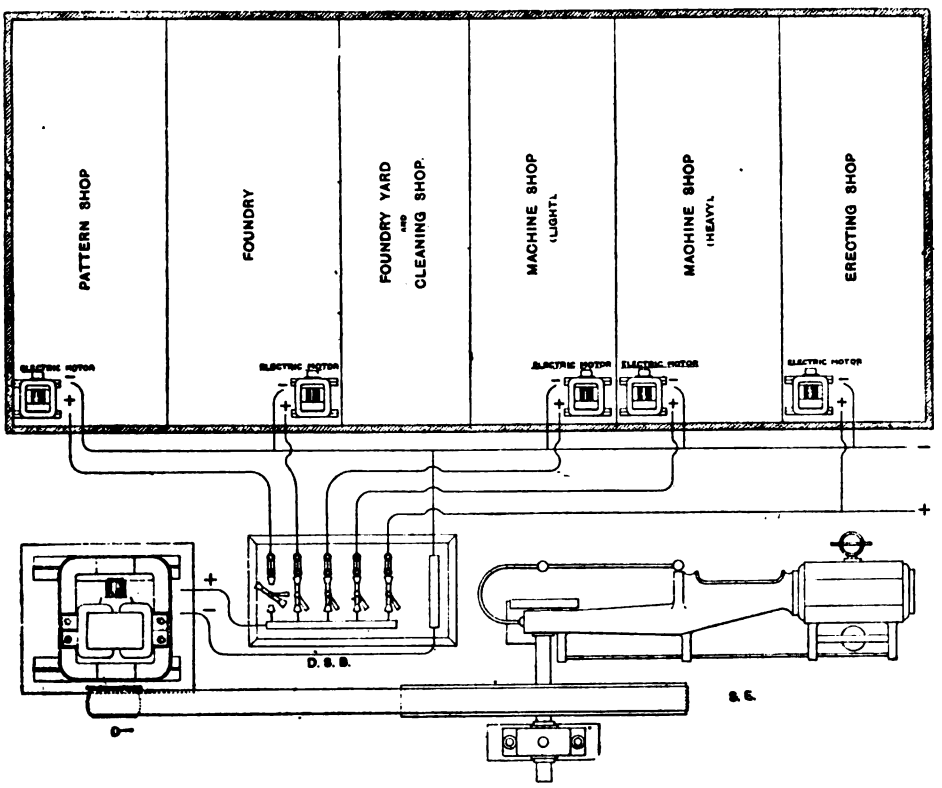

DIAGRAM II.

power of the engine and the horse-power given off at the motor spindle will be :

$$\frac{25 \times 100}{43·5} = 57·4 \text{ per cent.}$$

The writer trusts he will be pardoned for going so fully into this formula, but it is the formula by which the efficiency of any transmission of power plant is governed, and it will be necessary to apply this formula to any scheme which may have to be carried out, and he thinks it will be of value.

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Diagram No. 1 represents the system described above, and on this diagram the sizes of cable are given for reference. Diagram No. 2 represents a transmission of power installation, and shows the method adopted where electric motors are fitted into each shop. On reference to the diagram, it will be noted that a horizontal steam-engine, marked S E, drives on to the dynamo, D. The current from the dynamo is taken to a distributing switchboard, marked D S B, and from this point five branch positive mains are led to five motors placed in the pattern shop, foundry, machine shop, heavy machine shop, and erecting shop, the negative mains being coupled together and returning to the distributing bar on the distributing switchboard. This diagram fairly represents the arrangement that would be adopted in a works where it is intended to drive each shop with a separate motor, and may be useful as indicating the general lines upon which a plant of this description should be laid down and the method of running the cables to the motors.

It would be an advantage in a system of this kind to have a separate ampere-meter to each circuit, so that the current flowing to any motor can be seen at a glance. This would be a further indication that the motors are working satisfactorily, and in the event of any particular motor taking more current than it should do under normal conditions, the excess current could be instantly checked and waste prevented.

Diagram No. 3 represents a transmission of power plant where separate motors are used for the large machines, and one motor for driving the line shafting for driving the small machines. On reference to the diagram the steam-engine is marked S E, the dynamo by D, and the main switchboard by M S B. From the main switchboard a pair of main cables are run round the shop, and the various electric motors tapped off in parallel, contact being made simply from the positive and negative mains to the positive and negative terminals of the motors. It will be noted from the diagram that the shops in question, and which may be taken as representing the machines in an ordinary machine shop, consist of two planing machines, one large face plate lathe, one large shaping lathe, and one drilling machine, each of these machines being driven by a separate motor, and six small lathes are driven by a motor which drives on to the line shaft, the lathe being fitted with the ordinary countershaft. From the above diagrams it will be noted that the principles upon which ordinary transmission of power plants are laid out is very simple.

(To be continued.)

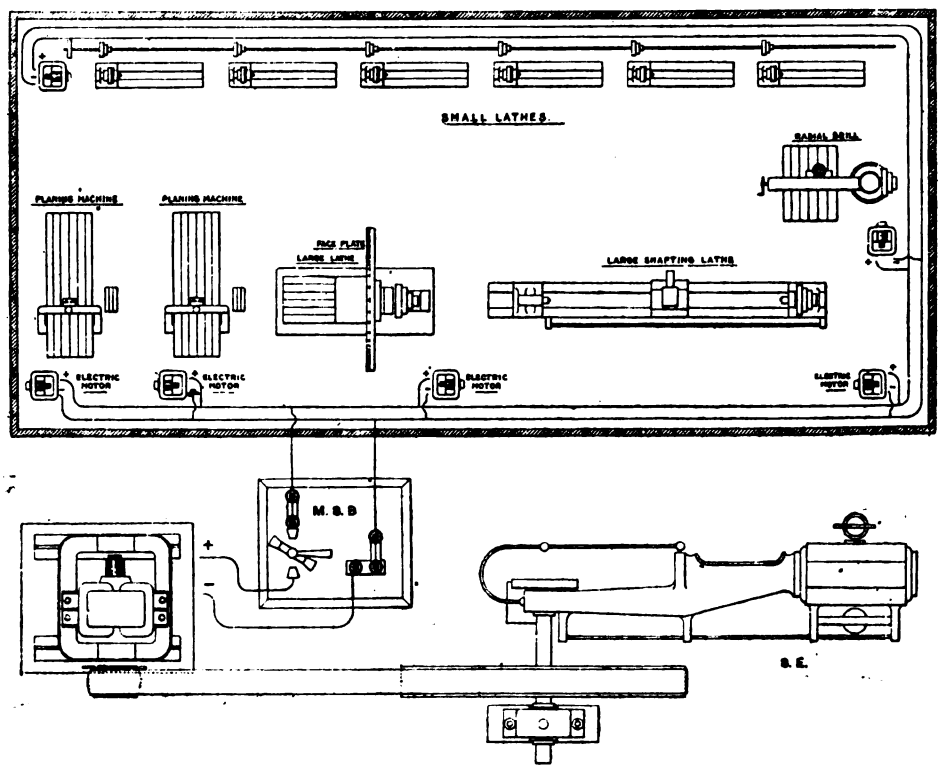

DIAGRAM III.

INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address by R. E. Crompton, M.I.C.E., President, Delivered at the Ordinary General Meeting, January 10.

I think that I shall interest you most if I address you on electrical engineering from my own standpoint. I believe that I am the first of your presidents who received his early training in mechanical and structural work entirely unconnected with electrical engineering, which at that time meant telegraph engineering. You must therefore not be disappointed if I deal with electrical engineering chiefly from the mechanical engineer's point of view, believing as I do that its great development dates from the time when the mechanical engineer first took in hand the design and construction of dynamo electric machinery. This date is that of the Paris Exhibition of 1878, so that we have had 16 years in which to develop the dynamo, the alternator, the transformer, and the storage battery into their present form. During these 16 years the dynamo, in mere size, has increased 500-fold, its efficiency has increased from 60 to 97 per cent.; from an instrument-maker's model it has become a machine which, whether as regards solid mechanical construction or smooth efficient working, will compete favourably with any form of engine or machine tool that has ever left the hands of the mechanical constructor. The modern alternator has been slowly evolved from the original Alliance magneto-electric machine, the transformer from the induction coil, the storage battery from the original Planté cell. When I say that the vast development which has taken place during these 16 years has been mainly due to the labours of the mechanical engineer, I do not in the least undervalue the immense labour of the physicists and of the telegraph engineers who preceded us; on the contrary, it is abundantly evident that this rapid development was only rendered possible by the splendid work which the physicists had already done, laying down so clearly the laws and the co-relation of E.M.F.'s, electric currents, resistance and induction, and to the admirable system of units which through the British Association Committee, the telegraph engineers had worked out to such completeness, that they now form, with very slight changes, the complete system of modern units that are universally adopted, and I cannot omit to mention the great impulse which was given to the progress of electrical engineering by the invention of the incandescent lamp by Swan, Stearn, and others. For it is quite certain that, although the development of dynamo plant for arc lighting and for transmission of power would have attained considerable proportions without the assistance which it has derived from the demand for incandescent lighting, yet it would have taken a vastly longer period to have reached its present stage of development.

I am one of those who, when I use the word "electricity," have before me a mental picture of an agency which we use for producing action at a distance, an infinitely flexible connecting

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rod by which we can transmit energy and reproduce it at a distance in any desired form. Perhaps the reason why I have formed this mental picture is that I entered on the study of electrical engineering though a very correct process of evolution. Having been previously engaged on a practical application of hydraulic transmission plant, I was, from the time that I first commenced on electrical work, struck by the general resemblance which the flow of electric currents through conductors bears to that of water or other fluids through a system of pipes. It is almost a pity that the actual demand for electrical energy for light-giving purposes preceded that for mechanical power purposes, as the part which electricity plays as a connecting rod only is not so immediately evident when it is reproduced as heat for electric lighting as when it is reproduced as mechanical energy in a motor. At a very early stage in the mechanical development of electrical machinery, the mechanical engineer found himself confronted with an entirely new set of problems; he found that the laws which govern the flow of the electric current and the formulæ he had to use were simplicity itself compared with those he had been compelled to master before he could deal with the design of any form of thermal engine, or even deal with the flow of fluids or liquids through pipes, the chief reason being that the electric current is so easily confined—"canalised," as the French call it—in its conductor by its insulation that the losses due to electrical leakage may in most cases be neglected, whereas the loss in thermal engines through the walls of the passages or confining chambers are so great, and form such a large percentage of the whole of the energy, and vary through such very wide limits according to their form and to the materials of which they are constructed, that the calculations involved in any new design are extremely complex. On the other hand, the mechanical engineer found that the necessity for so frequently interposing insulating materials between the various parts of electrical machinery greatly increased the difficulties of mechanical construction. Nearly all insulating materials are deficient in mechanical strength; in most cases they do not maintain their form through any considerable range of temperature, are readily damaged by oil or grease, and do not readily lend themselves to being cut or shaped by ordinary tools. Constructors of electric apparatus have to deal chiefly with iron, copper, and insulating materials.

The improvement in the electric qualities of the first two have been very marked, and we have probably arrived at finality, but we have made but little advance in the improvement of our insulating materials. Probably of all the materials that are available for insulating or isolating the parts of generating machinery, transformers, and distribution appliances, mica is the only one that at all approaches our requirements, and mica is only satisfactory when it can be applied in thin sheets to insulate adjacent surfaces of considerable area. Slate, porcelain, and enamel, when used as insulators, although they can stand considerable changes of temperature without alteration of their insulating qualities, are deficient in mechanical strength, and cannot be readily shaped or cut. Wood, hard rubber, and the various patent materials—such as woodite, vulcanised fibre—although they are more satisfactory as regards mechanical strength, are considerably affected by heat, moisture, and oil or grease. The various slates and marbles are mechanically weak, and unless protected by enamel are absorbent, and partially lose their insulating qualities in a damp atmosphere. Attempts that have been made to mould or cast insulating materials out of mica waste or similar substances cemented together by shellac, resin, or other adhesive materials, have only obtained partial success. In no case has the double requirement of mechanical strength been combined with that of resisting change of temperature or the absorption of moisture. This difficulty in obtaining satisfactory insulating materials has been the chief stumbling-block which makes the work of the designer of electrical machinery so much more difficult than that of the designer of ordinary metal work, where the necessity for insulating the parts does not come in. The improvement of the material that must be used for insulating the distribution system of conductors has been an equally difficult matter. The study of this question was forced upon us as soon as it became evident that electrical energy could be commercially supplied and distributed throughout our streets. The problem has been attacked in various ways. The various systems of insulation that have been tried can only be tested by time; it will be many years before we shall be able to predict with any certainty as to which systems are likely to survive. It is impossible for me to devote more than a few lines to this interesting question. As you know, the systems of conductors that have been hitherto laid divide themselves roughly into built-in systems, drawn-in systems, and those which use bare conductors insulated by glass or porcelain. Quite recently the attention, not only of ourselves, but of the public, has been directed by several accidents to the dangers attached to electrical conductors laid in the streets. In many cases these dangers are not properly attributable to the electric conductors themselves, but to the presence of gas in the soil through which these conductors pass. Wherever any space exists into which this gas can infiltrate, an explosive mixture may be formed, which may be fired either by an electric spark from the conductors themselves, or by contact with a match dropped by a smoker. I think, however, that there is no reason for the public to unnecessarily alarm themselves. In the vast majority of cases where the system of conductors is continuously inspected for traces of gas, no accidents of any kind have occurred.

Although I have already stated that electrical engineering is greatly indebted to the mechanical engineer for much of the development that has taken place in recent years, yet in some respects the reverse is the case. The alliance between us has not been wholly productive of benefit to us. An electrical engineer nowadays has to grasp the whole subject of the production and distribution of electrical energy from the energy contained in the coal to the point at which it is delivered to the consumer. As regards a very large portion of the plant he has to use, the electrical engineer has had to adopt the appliances already sanctioned by the mechanical engineer: I allude to the boilers, steam-engines, and to the motive power generally. When the electrical engineer called for a motive power on a large scale, he found ready to his hand the experience of those who had equipped the great factories of the manufacturing districts of England; and these gentlemen have had a considerable hand in the design and application of the motive power we use, and I am afraid that in many cases the combination has not been altogether a paying one. Previously to the introduction of power-houses for the generation of electrical energy, the large mill-owners were the principal users of power in England, and it is to their requirements we owe the developments of the Lancashire boiler and the refinements of the large slow-moving engines that are always found in such factories. These gentlemen are perpetually reminding us that in order to obtain the maximum of economical success we have only to copy their practice, and that anything that differs from their practice is wrong; and I am afraid a very considerable number of electrical engineers, particularly the younger members of our profession, have been considerably swayed by these utterances. I feel very strongly, however, that it is time to speak on these matters with no uncertain voice. The conditions under which we work our engines, boilers, and other motive-power plant for electrical supply purposes differ so widely from the conditions of motive power for driving factories that their experience is of little or no value to us—in fact, it is in many respects misleading—and I take it to the credit of electrical engineers that it is we who have been mainly instrumental in developing the newer types of engines and boiler plant which are now largely used in our supply stations. I think that few will doubt it was the exigencies of electrical engineering that led the late Mr. Willans to carry out his extensive series of experiments on the economical use of steam which has so revolutionised our ideas on the subject. If it had not been for the conveniences for accurate measurements which the dynamo and electric measuring instruments offered, Mr. Willans's experiments could never have been carried out to the convincing degree of accuracy which he attained. I think, from this and from other causes, that we electrical engineers are already beginning to return to the mechanical engineers some of the benefits that we received from them. I am sure that the considerations of load-factor and all similar matters, which have been found of great importance to electric supply engineers, will be found to have almost equal importance in the matter of water-works, gasworks, and many other industries. In a word, I believe that the studies which we have been compelled to pursue in order to investigate and deal with our electrical difficulties will prove to be of considerable service to the engineering world in general, and that the engineering world in general will gradually become more and more intimately connected, so that eventually some part of the training of every engineer who deals with constructive works or supply works of any form will be an electrical one.

Not the lightest of the duties of the modern electrical engineer is that of educating the public in the use of electrical energy. This process, which we in this room call the improvement of the load-factor, is a matter of such importance to you all that I need not apologise for dealing with it at some length. We not only desire to have the output of our generating station more evenly distributed throughout the 24-hour day, so as to fill up the valleys and reduce the peaks of our daily diagram, but we also wish to improve the summer diagram as compared with the winter one. The problem of satisfactorily and economically working the daily diagram may be, to some extent, dealt with by improvements in the storage of electrical energy; but even if we were in possession of as satisfactory a system of electrical storage as the gas companies possess in their gasometers, it would only help us to this point. The great disparity between our winter and summer loads is due to our geographical position, and will always exist so long as the major part of the energy we supply is for lighting purposes, and the obvious remedy is to encourage its use for motive power and for heating and cooking; and to me at the present time it appears a far easier matter to educate the public to the advantages of using electricity for heating than to induce them to use motive power to any considerable extent. For this reason I have persistently advocated the perfecting

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of electric heating and cooking appliances. This matter has not been much understood even amongst electrical engineers themselves. For a long time the opinion was very generally held that the energy required for electric heating is so great that its cost would be prohibitive. At first it was not seen how effectively electrically-heated appliances could be used for cooking purposes, how large a proportion of the heat units would be usefully employed in cooking food, and how small a percentage would be wasted in heating surrounding air. Now that this result has been obtained, and that cooking operations on a considerable scale can be carried on in an ordinary sitting-room without perceptibly raising the temperature of the air of the room, it will be seen that electric cooking is certain to obtain popularity in hot climates, or in summer, or in small tenements at such time when the lighting of fires and the waste heat from these fires is not only unnecessary but actually objectionable, and this even if the cost of the electrical cooking be considerably in excess of that by other means. At any rate, we may assume, if these expectations are only partially realised, that there will always be some sale of electricity for these purposes, and that the addition to our load diagram from such use will take the form of adding to it a parallel strip commencing from seven o'clock in the morning and ending at 11 o'clock at night, as I do not think there is anything in the condition of electric cooking to warrant anyone in thinking that the demand for energy for this purpose will be confined to the period immediately preceding each meal-time. The use of electricity for heating will be probably confined to the partial heating of rooms or parts of rooms which are required to be occupied for short periods or for the airing or warming of clothes or linen, and such use is also likely to be confined to the same hours as I have given for cooking.

Turning now to the possible extension of the load from the use of motive power, we know how large a portion of the income of the American supply companies has been during the past two years obtained from its motor load, and that up to the present our motor load in England, at all events in London, has been insignificant. I have attempted to find out, by putting questions to the managers of the most important American electrical supply works, whether the habits of the American people, or the construction of the dwellings in which they live or of their business premises, was such as to cause a special demand for motive power which would never arise on this side. It putting these questions, I fully expected to hear that their large motor load would be chiefly attributed to the driving of elevators, to the ventilating of their rooms during their exceptionally hot summers, and to the working of special machinery necessitated by their lofty buildings; but I am told that this is not so, that many of the large hotels and larger blocks of buildings possess their own separate plant for working their elevators and other machinery, and that the bulk of the motor load of the electric supply stations is obtained from the buildings of a moderate size, and that in these the motors are used for small industries and for domestic work, both of which uses are likely to exist to an equal extent in London or in any large English towns. If this is the case, we may feel sure that the commercial enterprise of those amongst you who make and sell electric motors and the engineers of our supply companies who are so desirous of increasing their motor load will be sufficient to make it gradually approximate to the American one. In this connection it is curious to note that although we in our central stations are so anxious to increase the output of our plant, and hence our load-factor, by encouraging the use of electric motors, the main argument we must use to an intending user is that of all sources of motive power none can be worked with so little waste of power during long periods of idleness as the electric motor. In other words, the electric motor is the cheapest of all systems of driving machinery when the load-factor is at its lowest. To mention a very ordinary case. Throughout all residential districts there exist a considerable number of small shops for repairing, and in some cases making domestic furniture on a small scale. In many cases it would be an advantage in such a small shop if one or two machine tools, such as a saw and a moulding machine, could be occasionally used for preparing the material. Such a machine would require from 3 h.p. to 5 h.p. to drive it when doing useful work. In most cases these machines would be only used for a few minutes at a time, several times a day, the total use probably not extending to more than seven hours per week. If the user obtained his power from a central source of supply, and paid 4d. per unit for it, the total cost of working these two machines would only be about 7s. per week, although the above time would be made up of many short periods of use. If we add on an ample sum for the interest on the cost of the machines and motors, and for their maintenance, the total cost need not exceed £1 per week, so that it is evident that in many cases it would pay well to employ such tools and motors, rather than send work out to be executed at a sawmill. It is evident that if the same intermittent employment of power had to be obtained from a steam-engine or even a gas-engine, the total cost of full attendance and upkeep would be from £3 to £2 per week, quite apart from the many inconveniences and dangers attending the use of steam power in small premises. It is evident, however, that as you increase the hours during which these machines are worked, the electric motor will lose its advantages, and a point will be reached at which, first the gas-engine, and eventually the steam-engine, will be found to compete favourably as regards cost.

This argument of the cheapness and convenience of the electric motor for very intermittent supply of power is one which cannot be impressed too strongly on likely future users of power; but apart from what we can do in supplying power to such small industries, there is much to be done in this country in familiarising the minds of the inhabitants of Mayfair and Kensington—to take these districts only as typical of many others—that the use of motive power in private houses need not be limited to working lifts, driving sewing-machines, knife-cleaners, grinding coffee, or even, as has been stated in another presidential address, "brushing their boots, washing their faces, and serving their meals." With great deference to the gentleman whose words I have just quoted, I must submit that there has hitherto been a certain want of imagination shown whenever the question of the possible extended use of motors has been discussed. No one can help noticing that amongst English women and English men, at any rate, the desire to work at home, to make something useful or artistic, or to decorate or to beautify our homes, is very widely spread. The number of those who employ their otherwise idle fingers during their leisure time in some kind of work is very great, but hitherto this work has been confined to sewing, embroidery, etching, painting, light carving—at any rate, to work where the muscular exertion required is small. This practically excludes any constructive or decorative work which requires to be made out of materials of a hard and enduring nature, but if once the electric motor is pressed into our service, if the electrically-driven shaper or graver needs only to be intelligently directed by the user, the most delicate-handed lady could cut and carve out designs in the hardest materials with the same ease and same certainty that she now uses the embroiderer's needle or the etching pen. There is one use to which electrical energy can be applied in very considerable quantities in residential districts. I allude to the production of artificial cold by means of electric motors. You all understand that this is at present done by arranging them to drive an air-compressor, and afterwards expanding the compressed and already cooled air into any properly constructed cold room in which it is desired to maintain a temperature sufficiently reduced to store perishable eatables—such as meat, fish, game, and vegetables or fruit—for long periods. Such cold storage would enable each consumer to deal far more directly with the producer than has hitherto been the case; the cost of several daily deliveries of food articles would be practically abolished, and the extravagances and waste of housekeeping would be reduced to the lowest possible limit; in fact, the advantages of such cold storage are so obvious that it is unnecessary to further insist upon them.

There is another development of the use of electricity for motive power to which I think your attention should be directed. The president of the Institution of Mechanical Engineers, in his address to the mechanical engineers in April of last year, drew attention to the efficiency that we claim for electric transmission of power to machine tools, and compared it with the efficiency of existing systems. I have Prof. Kennedy's permission to use his address as a means of carrying this highly interesting problem a step further. He said that "in any given factory running on the ordinary system there is a large continuous waste of power due to the running of the whole shafting, no matter how many or how few are at work; under such conditions the waste work in shafts and belts may well be 25 per cent. of the average useful work, and the distribution of total work may be approximately:

For the useful work	100
Wasted in belts	25
Wasted in engine friction	20
	145"

He compared this with an electric transmission as follows:

Useful work	100
Wasted in motors and dynamos	24
Wasted in leads	2
Wasted in engine friction	20
	146

So that he shows that the two sets of figures are practically the same as to amount of power required. I think that the cases where the comparison would work out on such equal terms would be very rare indeed, and would only be likely to apply to textile or similar factories. In engineering shops, where the time during which each machine tool is standing for the work to be fixed is very large compared with the time that the tool is actually running, I think it would be not too much to say that n most such shops the useful 100 h.p. he gives in his first table

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might be divided by 3, the other losses remaining constant, so that the average useful effect throughout the day is not as 100 : 145, as given by him, but rather as 33 : 78 ; in other words, the average efficiency, instead of being 68½, would be really about 42 ; but in such a case, if electric transmission with separate electric motors for each tool be used, the efficiency can remain at 68 as before. Therefore I believe that the cases where electric transmission of power can be substituted with considerable advantage over present systems are far more numerous than Prof. Kennedy's figures would lead us to suppose. It will be noticed that the difference between my assumptions and those of Prof. Kennedy lies chiefly in our estimates of the load-factor of each of the tools.

Several times when addressing you here I have used the term "load-factor" to denote the ratio which the total useful time during which the appliance is worked discontinuously bears to any given period, whether it be an hour, a day, or a year. As you know, I found myself compelled to investigate this question when dealing with the cost of electrical energy in my paper before the Civil Engineers ; but this load-factor question has a far wider application. If any attentive observer walks round a factory where machinery of any kind is being used, and takes careful note of the relation of the periods of useful work of each mechine to its periods of idleness, he will be struck by the large proportion which these hours of idleness bear to the hours of usefulness. As regards the machines themselves, the only loss caused by these long periods of idleness is that due to the interest on the money invested in them ; but in the case of the engines which drive them, or of the transmission devices, such as shafting or belting, in addition to the loss of interest, there are continuous losses due to the waste of power and cost of attendance that is required to keep them in motion at the required speed during these idle periods.

This matter is of great importance to us electrical engineers, for of all methods of transmission of energy that now exist, none can be worked with so little waste of power during these periods of idleness as electrical transmission. I have already shown this to be the case where the source of power is obtained from an electric supply station, and it is certainly the same in any works where any considerable number of tools are required to be intermittently driven.

One of the chief difficulties that have been met with in replacing the muscular energy of ourselves or of animals by that of the forces of Nature has been that of providing a variable ratio between the two factors of speed and torque that is necessary if we have to obtain from a constant source of energy the varying duty that we usually demand from our muscles. All our machine tools are provided with a few changes of the speed gear which forms a clumsy approach to this requirement. I have sought in vain for a short expression to define such a variable gearing, but am obliged to content myself with calling it "speed torque ratio gear." In all attempts to carry this out mechanically the change of ratio can only extend through very narrow limits, and at the outside four or five steps in the change of ratio can be given. Mechanical engineers for many years have been looking for such a gearing which will vary the ratio exactly as required, and not by steps. The nearest approach to this has been by two reversed cone pulleys with a round belt of constant length, which is moved or retained in any desired position by a fork sliding in guides. Quite recently Mr. W. W. Beaumont has introduced a mechanical variable ratio gear which is a decided improvement ; but in my view the first real step which promises to revolutionise our ideas on these matters has been the working out of this problem in the electrical portion of our plant—*i.e.*, in availing ourselves of our really flexible connecting rod, electricity itself.

One arrangement of this kind has been worked out in America by Mr. Ward Leonard. If it is desired to provide from a constant source of energy at the axle of the motor, C, either great torque at very low speed, or the same energy in the form of reduced torque at the higher speed, this is done by Mr. Leonard by passing the energy through a motor generator, A B, the motor, A, of which may be either an electric motor driven from a central station, or a steam, gas, or water engine, but in every case delivering a constant supply of mechanical energy to the spindle of the generator portion, B, the armature of which is connected by short conductors of low resistance to the motor C. If the magnets of motor C are kept supplied with a constant field from a constant source of supply, and the magnets of the generator, B, receive a variable degree of excitation by inserting a rheostat in series with them, so that the field may be varied through wide limits, by commencing with an extremely weak field in the generator, B, the motor C can be started with a large current, giving large torque at low E.M.F., then as the excitation of the field of B gradually increases, the E.M.F. of the generator and of the motor will also be increased, and at the same time the torque diminished, so as to get the spindle gradually into motion, and the machine driven by the motor C steadily brought up to its proper speed.

I give the description of this beautiful electrical gear just as it is given to me, and am told that there are no difficulties found in working it in actual practice, but I feel sure that it is only one of many similar methods by which this variable torque and speed ratio can be worked out electrically, and with a simplicity in the moving parts resembling that of the muscular system of the animal world. The application of this invention to working long lines of railway would appear to get over the great difficulty which would be due to the heavy fall of potential which occurs at the times when large currents are taken by the ordinary train motors whenever a train starts from rest, this difficulty being only slightly reduced by the device of motors arranged in series, and afterwards switching them into parallel. With Mr. Leonard's arrangement a long line may be worked at a high E.M.F. of 10,000 volts, generated by monophase alternating machinery, transformed at intervals and supplied to sections of the line at an E.M.F. sufficiently low to be easily dealt with—say, 500 volts—but still in the form of an alternating current. This alternating current could be collected from the line and used to work the motor A, as the arrangement I have just described would allow that this motor A should be a monophase synchronising motor, worked at extremely high speed, and having the generator, B, driven by it ; the generator, B, and the main motor, C, would be of the continuous-current type, and there is no reason why the motor C should not be of extremely low E.M.F., and consequently easily made direct-acting on the driving axle.

I have described this invention at some length, for, although it may have been noticed by some of you, it has probably escaped the notice of many who are engaged in thinking out the interesting problems of electric traction, haulage, or other uses to which the use of electric power is every day being applied.

We electrical engineers are frequently complimented on the perfection to which we have brought our measuring instruments, and in most cases this praise has been fairly earned, but I think some protest should be made against the very impossible degree of accuracy which is often claimed for electrical measurements. Such claims for accuracy those more thoroughly conversant with the subject know to be unwarranted ; they arise from an incomplete appreciation of the difficulties which attend the making of very accurate measurements of any kind. We often see the efficiencies of the various classes of electrical apparatus worked out to several places of decimals, when it is well known that no instruments exist which could record the measurements to this degree of accuracy. Electrical measuring instruments depend in the majority of cases on the accuracy with which they can indicate the amount of the minute forces to which their moving parts are subjected. In order to make them as sensitive as possible, these moving parts must be delicately adjusted or suspended, and the accuracy of the readings depends entirely upon the degree to which the instrument can be depended on to reproduce exactly the same readings under the same conditions as those observed when it was originally calibrated. It is evident, however, that this accuracy can only be maintained if the friction of the parts and their correct position and the strength of the controlling forces remain exactly the same as they were at the time of calibration. In practice it is found impossible to guard against minute changes in these conditions ; so that, however accurately the instrument of precision may be calibrated in Scotland, the very delicacy of its pivoting or suspension, which are necessary for accuracy, make it quite certain to lose its correct calibration after a journey to London, and no one could swear to the correctness of the readings. The case becomes worse if such instruments have to be used as travelling standards of reference. Take the very common instance of an inspecting engineer going to a maker's works to test the efficiency of a steam dynamo, the passing of which may depend on 1 per cent. of efficiency. In order to simplify this matter, I will suppose that there is no dispute as to the measurements of indicated horse-power, but that it is confined to the difference between the electrical readings of the maker's instruments and those of the inspector. One per cent. error in the readings of either current or volts, or ½ per cent. error in the readings of both of them, is sufficient to reject the machinery. How is it possible for an inspecting engineer to avoid dispute? How can he say that he feels more confidence in his instruments than in those of the maker? The balance of probability is that the maker's instruments, having remained *in situ* since their calibration, are less liable to error than the travelling instruments, which may have received shocks during their journey. If, however, the dispute had not been an electrical one, but had turned on questions of size or weight, the size measurements would have been easily dealt with by the ordinary steel rules in the shop, which can generally be depended upon to one part in a thousand ; and the weight would have presented no difficulty, as, if an ordinary beam balance were available, it could be adjusted in the presence of both parties, or, at any rate, the positions of the standard weight and of the object to be weighed could be exchanged, so that the mean of the weights thus taken would give the correct result. I have always thought that all important and accurate electrical measurements should be as easily checked and referred to a standard as the measurement of weight can be in the beam balance, but no existing measuring instruments having moving

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parts can be thus easily checked. For this reason, for the past eight years I have been attempting to reduce all electrical measurements to a balance of electrical forces—that is to say, by referring them to a standard fall of potential obtained on a carefully calibrated slide wire—in other words, the potentiometer. I have occupied much of my leisure time during the above period in perfecting this potentiometer system, which is already well known to most of you. I only mention it here in order to point out that with this instrument there are no moving parts, and that the only calibrated portion—the slide wire—can be subjected to extremely rough treatment without altering the accuracy of the instrument to any material extent. Once this slide wire is accurately divided, and that portion of it on which the sliding contact works is made of equal and even resistance per unit length, and is stretched rigidly over an accurately divided scale, it is almost impossible for the instrument to lose its calibration, short of actually severing the wire; and even if the wire is severed, a new wire can be applied and calibrated without the necessity of sending the instrument home to the maker, or to any standard laboratory, in order to compare it.

Whilst on the subject of electrical measuring instruments, I must not neglect to notice that very beautiful instrument, the bolometer of Prof. S. P. Langley, and its recent developments in the hands of Messrs. Lummer and Kurlbaum. The bolometer is really the most refined method of measuring temperature that has yet been proposed. Its readings are obtained by measuring electrically the varying resistances of a platinum film when submitted to minute changes of temperature. It is, in fact, Siemens's electric pyrometer, or Callendar's platinum thermometer, in its most complete form.

I should also not fail to call your attention to the splendid work of Prof. Callendar and Messrs. Griffiths and Clark in perfecting the platinum thermometer. By the aid of this instrument, and by electrical means, Messrs. Griffiths and Clark carried out the most recent determination of J, the value of the mechanical equivalent of heat. In my own practice I have found that the ease with which the platinum thermometer can be used in connection with my potentiometer system has given to me the most accurate, sensitive, and convenient methods of measuring temperatures in the various electrical apparatus which I have to examine. Anyone who possesses a potentiometer can take almost simultaneously any desired number of temperature readings by employing a number of platinum coils all made equal in resistance to an external standard with which they have been compared and adjusted at the temperature of melting ice. The external standard must, of course, be of manganin, which at ordinary temperatures has practically no temperature coefficient. If we adjust our potentiometer so that the readings on this standard are equal to 100 on the scale, the readings taken over the various platinum coils that are coupled in series with it will give directly the percentage rise, from which the temperature can be read off on a table calculated from the temperature coefficient of that batch of platinum wire.

I do not know if this beautiful method of measuring temperature is generally known to electrical engineers who are investigating such matters as the changes of resistance due to changes of temperature in insulating materials, the rise in temperature of the various parts of dynamos, transformers under varying conditions of load—in fact, in the everyday quantitative work of the electro-dynamic designer.

I have stated that in my researches I have adhered rigidly to the principle of making accurate electrical measurements by obtaining a balance of E.M.F.'s—in other words, by using a zero method. I should here explain that there are two zero methods—namely, that obtained from the simultaneous balancing of two forces, as in the Wheatstone bridge or any other split-circuit device; the other, by balancing each of the two forces in turn (*i.e.*, the one to be measured and a standard with which it is to be compared) against a third force, the two comparisons being made as quickly as possible one after the other. This is the zero method that I prefer, as it avoids the very great possibilities of error, which I find are likely to arise whenever divided or shunt circuits are used. With this latter method the determination of several falls of potential can be obtained off different portions of the same circuit through which one and the same current flows in series. One can be certain that, apart from the minute variation due to the difference of time, the conditions of current-flow are absolutely identical. From my point of view the only permissible use of shunt circuits is in the potential leads attached to the two points, and by means of which the difference of potential is measured; but a circuit through these leads cannot strictly be called a shunt to the main circuit, for, although a small current may be passing through it before perfect balance is obtained on the potentiometer, as soon as such balance is obtained absolutely no current passes through this potential lead circuit, so that any change in their resistances, or in the resistance of their contact with the standard conductor, does not affect the readings. For accurate measurement of large currents we use sheets or strips of suitable alloys, so as to reduce the correction for change of resistance due to change of temperature as far as possible. The copper-manganese nickel alloy called "manganin" has turned out to be very useful to us in this respect. It has the great advantage of having a falling curve between the temperatures of 30 and 70 centigrade, and can consequently be compensated by being combined with a metal having a rising curve, in such a way as to produce a standard having no temperature correction necessary between the above limits.

No doubt you will expect me to say a word on the subject of electric storage. Although comparatively little has been written or said about the improvement in the design and manufacture of the lead secondary battery invented by Planté, yet the progress in its development has been quite as marked and quite as satisfactory as that of the dynamo machine or alternator. I do not allude to new patterns of accumulators which claim to be new inventions, but solely to the improvement in detail and in manufacture which has followed on the competitive use of well-known existing forms. No doubt one reason why members of this Institution are not kept as well informed on the development of the storage battery as on other subjects is, that the questions involved, being electro-chemical ones, are extremely complex, and require long periods of time for their thorough investigation. Moreover, I regret to say that a dead set has been made at accumulators by some members of this Institution, who never rise in their places to mention them otherwise than by a sneer. It is curious this should be so. The secondary battery demands as high qualities for its patient investigation as does any other branch of electrical engineering; and those who are never tired of telling us that they cannot see the importance of improving electrical storage as much as that of any other portions of electrical plant, only show that they have a very incomplete grasp of the requirements of our art. At any rate, if we can judge from cost price and from cost of upkeep only, the advance in the construction of accumulators during any period—say, the last 10 year or last five years—has been quite as rapid as that of the advance of the construction of dynamo-electric machinery. A reference to the price-list of makers of dynamos and accumulators will show that this is the case, and from my own knowledge I can state that recent improvements are reducing the cost of maintenance to an equal extent. The study of the proper application of accumulators for electric supply is not confined to the design of accumulators themselves, but to the many adjuncts necessary to use them to the best advantage. The difference between the E.M.F. of charge and discharge has been satisfactorily dealt with by the various booster systems that have been introduced during the last two or three years; and the proper proportion which the output of the accumulators themselves should bear to that of the station, and the most economical size of generating unit to charge these accumulators, have also been carefully worked out.

It is probable that most of the early troubles with accumulators were due to want of knowledge of the necessity for extreme purity in the materials used. These impurities concentrated themselves in the active material on the negative plate and caused the now well-known phenomenon of self-discharge of the negative plates, which of itself is sufficient to account for the majority of the early breakdowns which at one time appeared to be so mysterious. We know how important it is for dynamo construction to have iron absolutely free from manganese and copper from arsenic, minute quantities of these, which could hardly be detected by chemical analysis, having the effect of largely altering the permeability of the iron or the conductivity of the copper. No less it is the case that minute quantities of certain metals, such as copper and arsenic, have an equally prejudicial effect in the lead used for accumulators; and the discovery of this effect has had a most important effect on the cost of manufacture and the cost of upkeep.

I feel that I should be failing in my duty towards you if I did not raise a note of warning on a point on which I feel very strongly. Owing to a combination of causes, the chief of which has been the great extent to which public money is now being spent on electrical supply undertakings, the control of large sums raised on the security of the public rates has been placed in the hands of very young engineers whose engineering life and experience has been a very short one. I am afraid that in some cases the extent of their responsibility has not been as fully realised by these gentlemen as it ought to have been. Local and special requirements have been insufficiently studied, designs have been hurriedly prepared, the *pros* and *cons.* of the various systems which could be used have been inadequately balanced, and I feel great misgivings as to the criticism that will be passed on these hurried designs after a few years have passed. I go further than this. I think that in many cases failure in part or in whole will follow, and so soon as this takes place a reaction will set in which will damage the interests of our profession almost as much as the speculation in electric light companies' shares in 1882. We all know, or ought to know, that an electric supply system, to be successful, ought to be worked out from beginning to end as a complete scheme, with due regard to the special conditions of the town as to probable light and power requirements, and to the habits of the people; and that this is a very different thing from the mere preparation of a design

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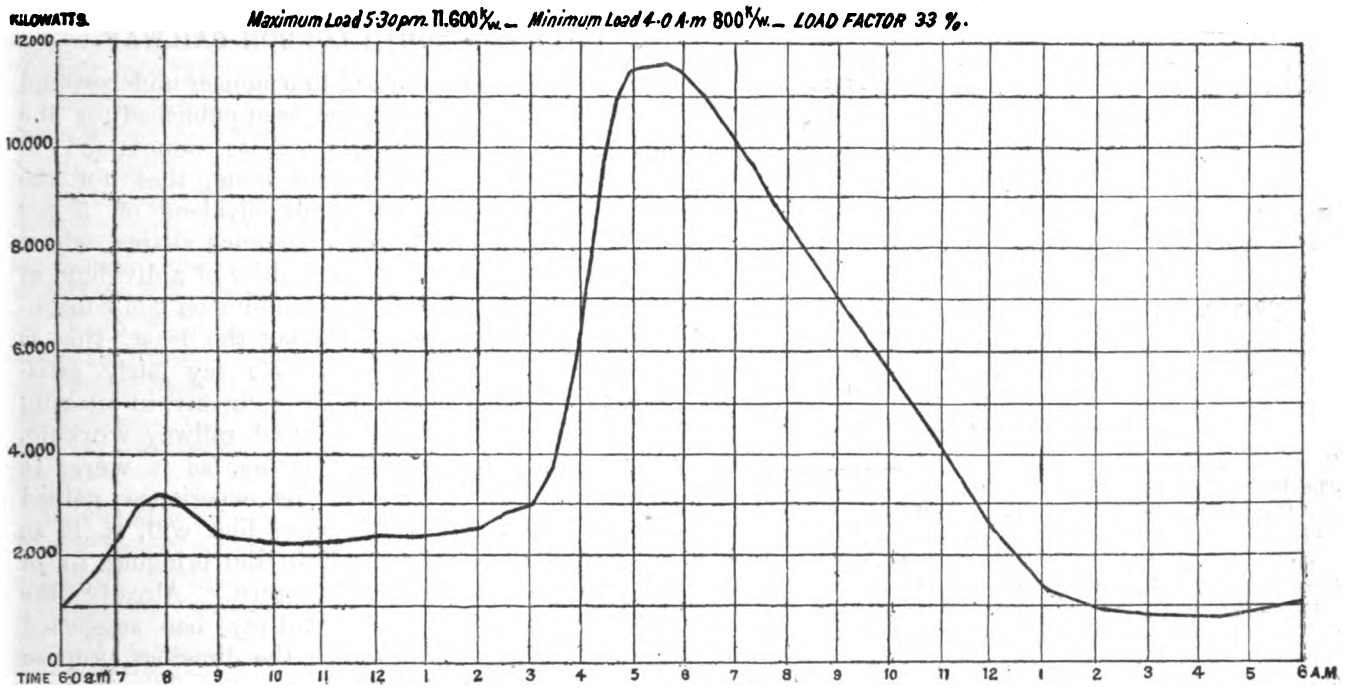

Load Curve, showing the Combined Output of the whole of the London Central Stations during the 24 hours ending at 6 a.m. on the 20th December, 1894.

for a building containing some plant, for laying a few miles of mains in the principal streets, with variations in the shape of providing power from the dust destructors or utilising thermal storage, in order to humour the vagaries of those of the electric lighting committees who fancy themselves engineers. I fear that this Institution is in some degree to blame for this: the papers that have been read, discussions that have taken place, have turned far too often on purely scientific matters, of interest only to the scientific men who took part in them; and that this has thrust into the background the more prosaic matters, which must be studied by those who hope to deal thoroughly and economically with the many and varying conditions of electric supply.

I hope these remarks will be taken in the sense that they are intended to be taken. It is even now not too late for those who are already carrying on works to inform themselves more fully than they have hitherto done on what is going on around them, and on the respective merits of existing electrical engineering practice. I know that many of those who are now so engaged, and who are responsible for the designs of the supply works that are now arising throughout the United Kingdom, and many of those who are now on the look-out for such employment, are setting out insufficiently equipped for their task; they have, I fear, studied their subject too much as book students, and have not spent sufficient time on travel and on the careful study of electrical machinery as it exists in England, the Continent, and America. As an engineer intimately connected with the management of several important supply works, I know that the number of young engineers who really attempt to practically examine and study the working of existing supply works is small. If I ask the engineers in charge of these works how often they receive visits, or have really serious enquiries addressed to them on these matters, I am answered that such enquiries are practically not made; in fact, I am afraid that the interchange of ideas, the comparison of experiences in the use of various novel kinds of plant, the exchange of statistics, exists chiefly among us the older members of the profession, and that although we are most willing to impart what we know to our younger brethren, we are practically never asked to communicate the results of our experience.

I hope also that what I am now saying will not be put down to the natural conservatism or grumbling of an older man dissatisfied with the existing order of things. Think the matter over for yourselves; compare the length of time that you have occupied in your training, and the number of years' experience that you have in your new profession, with that of the engineers employed in other branches of engineering who are put in charge of undertakings of equal importance. However brilliant may be your talents, you cannot hope to acquire that unerring critical faculty that power of rapid decision between two methods that offer themselves to you, of dealing with an engineering difficulty, and which was so ably described and put before Section G at the last meeting of the British Association by one of our members—the president of that section, Prof. Kennedy—until you have added years of practical observation to your training as a pupil, or your workshop experiences. I feel sure that Prof. Kennedy will allow me to quote his own words: "The whole use of college training, of workshop practice, of practical experience, is to provide the engineer later on with the means of critically examining each question as it comes up, of reviewing systematically the *pros and cons.* of each method of dealing with it, of coming finally, rapidly, positively, to some definite condition, which may then be irrevocably carried out."

I am now addressing the whole body of electrical engineers, old as well as young. None of us are too old to learn and profit from the experience of others—in fact, as I have already said, I find that such interchange of ideas as now exists is far more among the older than the younger members of our profession. This is much to be regretted. It may be partly due to the diffidence or shyness of the young men, but I greatly fear in many cases it is due to their fear that their crude and hastily formed ideas may be adversely criticised. Never during the 16 years which I have named as the life of our art have there existed more momentous questions to be solved than at the present moment; and, if I can by my words induce a freer interchange of ideas, so that we help one another more than has been done in the past, I shall feel that I have been of some service to the Institution. Such interchange takes place most naturally in the tea-room after each of our discussions. I think the time spent in the tea-room is very valuable, and is far too short; and I think the practice, recently started by the Institution of Civil Engineers, of prolonging the evening meeting in the form of throwing open several rooms in which may be exhibited models of new instruments of interest is a good one, and might be with advantage copied by us. This time after the meeting is often much curtailed by the length of the discussions, and I hope that you will support me in the chair when I try to shorten the discussion, particularly when it runs away on matters irrelevant to the paper of the evening.

The ideal method of best spending the time of the session is in discussions on the points of most interest to us at the time—*i.e.*, on burning questions which might be started by comparatively short papers, printed and distributed before the discussion, so that the whole evening might be devoted to it. I, for one, hope that we shall have free, fearless, and open discussion on all matters which affect our art. Let us keep away from any imputation of personal motive, but at the same time let us not hesitate to condemn as well as to praise, simply because such condemnation may appear to hurt the commercial interests of A, B, or C. I say advisedly "appear," because honest criticism in most cases is likely to prove to the advantage of A, B, or C, as it may open their minds to matters which they had never had fairly put before them.

After such a long spell of what I am afraid you will consider too plain speaking on my part, I end my address by calling your attention to the diagram on the wall which shows the combined output, or load, of the London electric supply stations for a night in December, 1894, and which was taken simultaneously for the purposes of this address, and for which I have to thank the engineers of the supply companies. I have not had the opportunity to compare this with the load of any other city in the world, but I fully believe that it will be found to be one of the largest that has ever been drawn out—at any rate, we electrical engineers, with such a diagram before us, can point at all events to the very substantial degree of development of supply of electric energy in London.

I have to thank you for listening patiently to what, after all, is a recapitulation of facts which have been already known to many of you. I can only hope that they were not known to others, and that they may be of use to them.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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CITY AND SOUTH LONDON RAILWAY.

Although the accounts of this pioneer underground electric railway have not yet been published for the past year, the company state, as announced in another part of the present issue, that for the half-year just ended the full dividend of 5 per cent. is available for the preference shares, whilst the accounts for that period allow of a dividend at the rate of 1¼ per cent. per annum on the consolidated ordinary stock. To say the least, this is a fairly satisfactory result. We say fairly satisfactory advisedly, because the company, in making a new departure in underground railway working, have been hampered by having, as it were, to work in the dark; but the experience gained in the operation of this short line will, it is to be hoped, eventually result in the bringing in of a substantial commercial return. Already the practical working of the railway has suggested certain improvements which the directors propose to carry into effect. One of these is in the direction of conveying additional passengers during the busy portions of the day, and for this purpose, as we stated some time ago, experiments are being made with carriages equipped with electric motors in preference to the employment of separate locomotives. By this means it will be possible to run a train composed of four coaches, the limit of the length of the station platforms at the present time being three and a locomotive. It would not be far wrong to suggest, apart from the electrical equipment, that if the company had to redesign the general construction of the line, considerable modifications would be introduced.

As to the dividend of 1¼ per cent. on the ordinary stock, this is an improvement over that in the corresponding period of last year, when it was at the rate of ⅝ per cent. per annum. In fact, the company have profited by four years' working experience, of which, it is needless to say, the promoters of similar undertakings in the Metropolis have taken advantage. The company have paid on the ordinary stock dividends of three-eighths, five-eighths, and five-eighths for the past three years, and the promise for the fourth year's operations is more hopeful. At the same time the line has had to pay for being a pioneer, and although a slight improvement is taking place, very material progress does not seem possible until the extensions to Clapham Common and to Islington have been carried out. When these have been accomplished, as we hope they soon will be, we look for a larger amount of traffic proportionately and to better returns.

TRANSFORMER-CHAMBERS.

As anticipated in the comments made in our editorial columns on the 7th ultimo, the Board of Trade has now formally intimated its decision upon the above subject to the London County Council, and other interested parties, in a manner favourable to the electrical industry, and in very much the same terms, moreover, as were employed by Sir Courtenay Boyle to explain the advice he proposed

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to give the Board upon the termination of the recent enquiry into this matter.

The essence of this decision is contained in two statements: first, that the expressions in the provisional orders with regard to boxes for regulating or controlling the supply of energy must certainly be held to include, if not specifically refer to, the appliances and means for transforming energy, and, therefore, transformer apparatus can properly be dealt with by the Board of Trade under the provisional order. The second statement sets forth that there is practically no limitation with respect to the size of the boxes—consistent, that is, with due regard to other users of the public streets.

As a matter of common sense, the decision of the Board is, of course, just what might have been expected. Whilst the electric lighting interests are undoubtedly justified on both technical and business grounds in avoiding private property for their transformer-chambers, yet it would hardly be proper that street-chambers should become actual sub-stations, and, therefore, due limits are set down for general use, to be modified or extended by the Board in dealing with particular cases. It is hardly conceivable to suppose that the use of such boxes or chambers should be altogether forbidden in London, for they are so devised on the score, not only of economy, but also convenience and safety—however much the latter may be disputed. Without doubt the London local or central authorities would themselves have followed the same course as that already adopted in this way by the electric lighting companies (and approved by the Board of Trade), if the former had undertaken the supply of energy in the first instance. Other towns and municipalities freely adopt the use of transformer-chambers in the streets, and find no trouble arising therefrom. Of course, we do not touch upon the legal powers which might or might not be thus handed over to the electric lighting companies, though a right of user for beneficial purposes ought surely to be granted at once without dispute—at a peppercorn rental, for that matter, if objections are felt on the score of taking way-leaves for nothing.

In every respect, therefore, the decision of the Board of Trade is an excellent one, and greatly to be commended. Perhaps the electric lighting companies have not obtained *all* that they would naturally desire, but some consideration is of course due to other public services, and hence the limits now defined. We do not see what the local authorities can find to object to in the present status. In many continental cities the transformer-chambers are not put underground, but are actually on the street or pavement level, enclosed in large and massive iron pillars like exaggerated street letter-boxes. What would be thought of such appliances on the London streets?

Electric Lighting in Italy.—Work has been commenced in connection with the electric lighting of Battaglia, Venetia.—A company is being formed at Biella to acquire the powerful Cana Vesano waterfalls, 18 miles distant from Biella. About 600 h.p. is available.—At Campobasso the electric light is to take the place of petroleum lighting.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

HIGH-INSULATION RESISTANCE.

SIR,—The following insulation tests may be of interest to you, seeing that the system adopted at Blackburn is the same as that at Nelson, put down by me in 1893, and which has proved so free from faults—viz., a three-wire system, consisting of cables continuously insulated with vulcanised rubber and supported upon vitrified stoneware bridges, and fixed within a cast-iron conduit kept water-tight by means of steel junction-pieces.

The following test of feeders and ring main and pilot wires took place at Blackburn in the presence of Mr. David McDowall Grosart, M.I.E.E., the consulting engineer to the Corporation of Blackburn, and Mr. T. L. Horne, A.M.I.E.E., representing Messrs. Siemens Bros. and Co., London.

The total length of cable laid is 6·75 miles. The insulation resistance, including pilot wires, is 190 megohms.

The test of the separate cables are as follows, after two minutes' electrification:

+	1,620 megohms per statute mile.
Middle,	1,530 megohms per statute mile.
−	1,580 megohms per statute mile.

The specification issued by me was for 800 megohms per statute mile. This result is therefore highly satisfactory, being nearly double the guarantee. The cables are of Messrs. Siemens Bros.' manufacture.—Yours, etc.,

THOMAS BARTON.

The Electric Works, Blackburn, January 15, 1895.

DIVIDED POLE-PIECES.

SIR,—I note in the description of the new dynamo which Messrs. Thomas Parker, Limited, have just introduced, that one of the novel features in it is the splitting of the magnet pole so that the armature can be readily taken out. I do not know whether this would have been considered a novelty about six years ago; if so, I am entitled to claim it, as I fitted all the two-pole dynamos which my firm have made for the past six years with the magnets split in the same way as Mr. Parker's machine. I have found it extremely convenient, as it enables the armature to be very readily removed if required.

At the same time, I did not consider it worth bringing very prominently forward at the time I designed and built the first two-pole machine, and I am quite sure that Mr. Parker, with the desire for fairness which I know he possesses, has not made this claim with any knowledge of what has been previously done.—Yours, etc.,

M. MOUNTAIN.

Newcastle-upon-Tyne, January 15, 1895.

UNDERGROUND CONDUITS.

SIR,—Having had considerable experience in the construction of underground mains, I am of the opinion that the best way to prevent these explosions is to properly drain and ventilate culverts and boxes. There is not much doubt but that these points have been neglected, or have not received the consideration deserved, at the time of the construction of some of the mains both in London and the provinces. I know that to lay tubes and culverts with proper falls to junction, etc., boxes, adds considerably to the difficulty in laying, owing to the many obstructions met with underground, and unless a very sharp eye is kept on the workmen the levels will very soon be neglected. At the lowest points, which must be at a junction or service box, it is a simple matter to construct a "sump" or "catch-pit," from which any water can be drawn at certain times. I am in favour of this system in preference to connecting to the sewers, as I have found that almost every form of "trapping" is likely at some time or other to fail, in which case sewer gas would be carried all through the district and into the houses of those using the current, with most disastrous effects. It was on this account that

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I abandoned a design which I worked out over four years ago. In districts near the sea or rivers there is also the danger of back-water from the sewers at times of high water or floods through any slight defects in the traps.

As regards ventilation, I would allow coal gas or any other gas to wander about as it liked underground, for although it may not be altogether impossible to keep it out of culverts, boxes, etc., it would be a most expensive business to attempt properly, as gas very soon finds its way through concrete or brickwork. Clamping caps over the ends of pipes, either spares or those carrying cables, would not protect the boxes themselves; besides, there would always be the risk of their being left off by the workmen. Dried air forced through the entire system of conduits and pipes is a splendid means of ventilating—in theory, but I have grave doubts as to its entire and complete success in practice, especially in the case of a large district or town where the network is connected up at many different points. There would, it seems to me, be certain portions of the mains—those farthest to reach or where culverts or pipes were of a smaller size—that would never reap any benefit; besides, there is the cost to be considered.

In the construction of new mains, it is, of course, much easier to make arrangements for both drainage and ventilating, and there is not much doubt but that in the future these questions will receive more consideration than they have in the past; but the matter which should be considered immediately is how to deal with those mains already in use. The different systems would probably be better dealt with separately and on their individual merits. What might be suitable to conduits may require modification for pipe mains, etc.

Putting the question of cost on one side, the business would be much easier dealt with, but, unfortunately, the cost must be considered, and with this in mind a system adaptable, with slight modifications, to the various kinds of mains in use would be to connect certain manholes or boxes (in the case of cable and pipe mains all junction boxes, and where these are too far apart some of the service boxes; in culverts, at all junction-boxes, and where these exceed about 50 yards, the service boxes at about this distance, and always at the end of a culvert) by means of an earthenware drain-pipe to a box (an ordinary gully trap will do), with a cast-iron lid in which holes of a combined area exceeding that of the drain-pipe are cast, each with a ridge round to prevent water running in. This box or trap should be fixed at a higher level than the manhole or service box, and as close as possible to a wall or building; it will then be sheltered from rain, dirt, and traffic. I have seen these successfully in use, and requiring very little attention.

There are, of course, other ways which might be better than these that I have mentioned, but I think for cost they will give good and satisfactory results.

For the sake of electric lighting, and to prevent further injury and mischief being done, this matter should be taken in hand at once.—Yours, etc.,

B. H. JENKINSON, A.M.I.C.E.

13, Mildenhall-road, N.E., January 16, 1895.

REVIEWS.

Proceedings of the International Electrical Congress held at Chicago, August, 1893. Published by the American Institute of Electrical Engineers, New York.

Probably those who attended the congress at Chicago 18 months ago carried away with them enough reminiscences to render any tangible reminder unnecessary, whilst the vast mass of electrical men who didn't go have retained only a memory of reports in the technical Press, dealing with attempts at unity in units, or comprising acres of pages on alternating-current theories, with here and there a few eminently practical results worth laying hold of for daily use. It is possible that *some* may have forgotten all about the congress and its objects, and to such the chance is now afforded of parting with their dollars to refresh their memories as to what was done, or—still more important—what was attempted. In a volume of some 500 pages, we have here a complete record of the entire congress—papers, discussions, etc.—accompanied by a photograph of the official delegates. Better late than never, it may be thought; though the publication of this report has been so long deferred that death has already claimed a foremost figure from the group depicted. No longer, alas! will Von Helmholtz be called to assist in work of this kind. That the rest are still amongst us is a matter for congratulation, and yet more so if they endure until the next congress, now not very far remote.

THE MAYORALTY OF TUNBRIDGE WELLS.

SIR DAVID SALOMONS'S BANQUET.

Reaching Charing Cross Station some five minutes before the train started on Saturday, I wondered what sort of a run down we should have. It was bitterly cold, with a piercing wind, and not even the attraction of the saloon carriages attached to the train was sufficient to prevent my becoming ensconced in the corner of a private smoking compartment. I had been invited to be present at the banquet given on Saturday by Sir David Salomons, Bart., to celebrate his election to the mayoralty of Tunbridge Wells.

My fellow-passengers were newspaper men—a jolly set they were. When we arrived at Cannon-street, the Lord Mayor (Sir Joseph Renals) and friends entered the train, which then resumed its uninterrupted course to our destination. Of the happenings during the journey there is little to say.

The representative of one paper, a red-faced man, wanted to know why Sir David was giving the banquet. Another thought it was to get an advertisement. I ventured to suggest that Sir David, being so well known, had no occasion to advertise himself, and that he would not attempt to do so. "Do you see this?" asked my *vis-a-vis*, handing me his card of arrangements for guests from London, "'Vehicles will be in attendance, should any gentlemen wish to avail themselves of these to convey them across the road to the hall.' Rare fun, is it not," he added, "vehicles to convey visitors across the road; why, it's only 30 yards."

No one seemed sorry when we reached Tunbridge Wells, where a guard of honour awaited us—I mean the Lord Mayor. It was still terribly cold, but this did not prevent all Tunbridge Wells from turning out to witness the arrival of the company. The members of the local volunteer corps, assisted by the fire brigade, kept order—and the cold.

Passing into the ante-room, Sir David, attired in his robes of office, and assisted by the Corporation, most graciously received us. I was unable to secure the plan of the tables allotted to me, and had to be content with that of Mr. C. Semark, who can have it on application to this office.

The dining-hall was very effectively decorated. At one end, where the principal guests sat, was a raised platform, on the front of which was a bank of ferns and other foliage plants; at the other end was another platform, where a portion of the Royal Engineers' band rendered a musical programme during the evening.

A glance round the hall showed many familiar figures in the scientific and legal world. Besides the Lord Mayor, the company entertained by Sir David included the Marquis of Abergavenny, Viscount Cantelupe, Lord George Nevill, Lord Sherborne, Mr. Justice Grantham, Sir Julian Goldsmid, M.P., Sir Frederick Abel, F.R.S., Sir W. G. Stirling, Sir George Russell, M.P., Sir Frederick Bramwell, F.R.S., the Astronomer-Royal (Mr. W. H. M. Christie, F.R.S.), Mr. Alderman and Sheriff Samuel, Mr. Sheriff Hand, Sir B. W. Richardson, Sir James Crichton-Browne, F.R.S., Prof. Hughes, F.R.S., Mr. Bousfield, Q.C., M.P., Mr. Alderman Faudel Phillips, Sir Henry Knight, Mr. A. G. Boscawen, M.P., Sir H. C. Mance, Prof. Ayrton, F.R.S., the Master of the Skinners' Company, the Master of the Coopers' Company, Mr. Macrory, Q.C., Sir J. Winfield Bouser, Mr. D. Fearon, and the mayors of Brighton,

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Eastbourne, Lewes, Folkestone, Hastings, and Maidstone, Mr. F. Webb, and others. Lord Kelvin was not present, and I was unable to find Mr. W. H. Preece, the consulting engineer to the Corporation.

The entrance of Sir David was heralded by two trumpeters, whose blasts seemed to somewhat vex the mayor. The ceremony resembled some mediæval function, and reminded me very forcibly of the external proceedings at the advent of judges years ago at the entrance to courts of assize. At the conclusion of the dinner, the toast list, which I give below, was proceeded with.

The toast list is, however, not sufficiently detailed. It does not mention that given by Mr. F. W. Stone—"Sir David Salomons"—to which Sir David suitably replied.

The Mayor—"The Queen"...	
The Mayor—"The Prince and Princess of Wales and Rest of the Royal Family"	
Sir George Russell, Bart, M.P.—"The Navy, Army, and Reserve Forces"...	Capt. Stiffe, late E.I.N. General Light, R A., ret. Colonel Sir George Stirling, Bart.
Sir J. Crichton Browne, F.R.S.—"The Houses of Parliament"	The Marquis of Abergavenny, K.G. Sir Julian Goldsmid, Bart., M P.
Lieut.-Colonel A. M. Brookfield, M.P.—"Bench and Bar"	Mr. Justice Grantham. Mr. Bousfield, Q C., M P.
The Mayor—"The Corporation of the City of London"...	The Lord Mayor. Mr. Alderman and Sheriff Samuel.
Mr. A. G. Boscawen, M.P.—"Neighbouring Corporations"	The Mayor of Brighton.
The Lord Mayor—"The Corporation of Tunbridge Wells"...	The Mayor.
The Mayor—"The Guests"..	The Astronomer Royal (Mr. Christie) Sir Benjamin Ward Richardson, M.D., F.R.S. Mr. W. F. Browell

Evidently Mr. JUSTICE GRANTHAM is a ready wit. In responding for "The Bench," he said that "the Mayor of Tunbridge Wells has given us a dinner. Without any desire to disparage his worship's hospitality, I think I can do better than that. I can give you not only food, but lodgings. I can give any number of men free board and lodging, with an extra present in the shape of six months' hard labour." Now, I think this is a little too bad. At any rate, I hope this statement was not the cause of the sudden disappearance of several of the guests.

Sir DAVID SALOMONS, in proposing the "Corporation of the City of London," mentioned the interesting fact that his uncle had once occupied the position of chief magistrate of the City, and referred to his connection with the electric lighting of the main thoroughfares of the City of London. Continuing, he observed that there were men who thought that institutions which had grown through centuries could be swept away in a day. That could not and would not be done. Many people imagined that Sir J. Renals would be the last Lord Mayor of the City. His own belief was that there would be many more Lord Mayors, and that among them would be his guests, Mr. Alderman Phillips and Mr. Sheriff Samuel.

The LORD MAYOR, in acknowledging the toast, remarked that the first of his Jewish predecessors as chief magistrate was the chairman's uncle, who did much for the cause of civil and religious freedom in this country. At present, his lordship went on to say, they were engaged in defending the privileges and prestige of the Corporation, which, although it had existed many centuries, was still young and vigorous. Whoever had the honour to respond to that toast in years to come, his lordship continued, would be able to declare, as he did then, that the Corporation of the City of London was still pre-eminent for the hard and enduring work and the generous and impartial charity which had distinguished it in the past.

In the course of another toast it was mentioned that in another month Tunbridge Wells would have available a municipal supply of the electric light.

Shortly after 11 many of the guests returned to town. The train stopped two or three times to set down visitors, and reached Charing Cross at 12.55, where the guests were welcomed by snow and cabs.

TRANSFORMER-CHAMBERS IN LONDON.

BOARD OF TRADE DECISION.

We give below a copy of the letter which has been addressed by the Board of Trade to the London County Council and other local authorities in the Metropolis. The decision in this matter concerns the House-to-House Electric Light Supply Order, 1889; the Hampstead Electric Lighting Order, 1892; County of London (North) Electric Lighting Order, 1892; Southwark Electric Lighting Order, 1892; Wandsworth Electric Lighting Order, 1892; and the Islington Electric Lighting Order, 1893. The letter is signed by Sir Courtenay Boyle.

"With reference to the hearing which recently took place at this office of objections raised to the various systems of supply proposed to be adopted by the undertakers under the above-mentioned orders, which involve the use of transforming-chambers placed underground in the public streets, I am directed by the Board of Trade to inform you that, as arranged at the hearing, they have consulted their legal adviser, who is of opinion that the expression, 'regulating or controlling the supply of energy,' means or includes the transforming of energy, and accordingly that there is sufficient authority in Section 12 of the County of London (North) Electric Lighting Order, 1892, and in the corresponding sections of the other orders mentioned above, for the construction of such boxes as may be necessary for that purpose; and, further, that, so far as the section itself is concerned, there is no limitation with respect to the size of the boxes.

"In view of this opinion, and after a careful consideration of the representations made at the hearing, the Board of Trade are not prepared to hold that sufficient reasons have been advanced, either on the ground of public safety or of want of parliamentary sanction, to justify them in refusing to approve of a system of supply which involves the use of transforming-chambers under the public streets. The Board of Trade, however, consider that the user of the public streets for such a purpose should be as much as possible limited, and that the chambers should be placed where they do not unreasonably interfere with existing underground works of any kind. In these circumstances the Board of Trade will be prepared to approve the systems submitted by the undertakers under the above-mentioned orders with certain alterations, which will be communicated to the Council shortly.

"The Board of Trade hope that their decision on the general question will render unnecessary any further action with regard to the appeals which have been lodged by the undertakers under Section 13 of the County of London (North) Electric Lighting Order, 1892, and of the Wandsworth Electric Lighting Order, 1893. Should, however, any difficulty arise in connection with any particular chamber, it would, of course, be open to the London County Council, the local authority, and the undertakers to avail themselves of the provisions of the sections of the orders relating to the construction of works."

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

Presidential Address Delivered January 14 by Mr. Henry Edmunds.

I feel a peculiar responsibility in addressing you this evening, and it is at some personal inconvenience to myself that I have come down here to-day from London, where I have to return early to-morrow. It was kindly suggested by some of the members that I might write my address and it should be read for me, but I felt it would be better to speak face to face, especially when I remembered that this was the first presidential address. Now, if we are serious and want this society to take a lasting and dignified position in the country, it is well for us to carefully consider the objects and future of the society, and see what each individual member can do to further the interests of the Northern Society of Electrical Engineers as a whole, rather than consider his personal convenience, business interests, and self-advancement. In some quarters the question is asked: "What need is there for such a society as ours? Have we not already the Institution of

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Electrical Engineers and other kindred societies?" The answer may be considered chiefly geographically. It is difficult for men living in the North to attend regularly the meetings held in London, and the mere reading of the proceedings of the London meeting does not compensate for the absence of personal contact and debate. This society is not an offshoot nor an affiliated member of the Institution of Electrical Engineers, but an independent body, though composed of men having kindred interests and tastes, many of whom, like myself, happen to be members of both the Institution of Electrical Engineers and the Northern Society of Electrical Engineers. Therefore, as an independent body, we must carefully consider what our aims, interests, and objects are, and see if they differ in any way from those of other institutions. If our objects are exactly alike, we may be said to be in competition; and if in competition, we must naturally try to excel and do better than those we compete with. I think a little competition among societies may be as healthy as in commerce. Now, we are a formed society, one year old; we have 125 members, a balance at the bank, and are financially sound. Our society is respected so far as it is known by kindred societies, and its papers and discussions have been published and commented upon by the technical journals, and now at its first birthday it may be said to have justified its existence. But what is its future going to be? That brings me to the most serious and important part of this the first presidential address. If we wish to live, grow, and be respected, each member must contribute his own individual effort. Each one must feel himself honoured by being elected a member of this society, rather than consider that he confers an honour to the society by joining it. I speak in this way as I fear that at some of the meetings during the past year this idea may have been overlooked. It is probably excusable when we consider the youth and consequent inexperience of the society, but as we grow older we must grow wiser and stronger—we must consider what the aims and objects of this Northern Society of Electrical Engineers should be. We may divide these objects into (1) the practical and technical; and (2) the social.

I put practical first, because in looking around me I see so many men who are interested rather in the everyday work of constructive electrical engineering than in the pursuit of scientific research. We may further divide our engineers into two classes—consulting and constructive. A word to the consulting engineer may be well brought in here. In the first place, the profession is an important and useful one. It is the duty of the consulting engineer to plan out, design, and to guide those who have no technical knowledge of their own. Corporations and individuals employ the electrical engineer in the same manner as they employ their architect, their gas or water engineer. But our profession is a young one. During my connection with it, which dates back from 1877, I have seen the gradual falling into rank of men who in 1877 were unheard of and unknown. The electrical engineer of that day was essentially a telegraph engineer, and his ideas, with few exceptions, were limited to the working of land or submarine telegraphy. I often think that the rapid advance of electrical engineering was retarded in consequence of the limitations to the mechanical and engineering side of the question, which limitations were set by men whose knowledge was mostly confined to magnets covered with fine silk-covered wire, and currents that could not vibrate the indicating needle of a modern central-station ammeter at zero. I would not for one moment reflect on the gentlemen of 1877, but only wish to indicate to you that the electrical engineer is a creation made since then. He has had a very long childhood, and, like the rest of us, has had a great deal to learn and unlearn. Naturally, when work was placed in the hands of the new engineer, when he became consulting rather than constructive, he was apt to please his vanity and try to justify his existence by changing every dimension and detail he possibly could in existing machinery and appliances. And it did not end with merely painting the machine another colour; but each engineer varied the speed of his dynamo, the pressure of his mains, the type of engine which should drive, and the thousand and one details which, while they might not interfere with the result of the whole, have had a very serious interference with the advance of the electrical industry. In England, I think, we have been as much cursed with amateurish engineers as they have been blessed in America with the absence of them. I recollect very well when I first met Mr. Brush in Cleveland, U.S.A., in 1879, and saw his very plain, but useful, arc lamp, I thought it might be considerably improved, and told him so. He looked at me, and said, "It works! What we have to do is to sell them." And they did sell. I was instrumental in the introduction of that system into England. Many people came to see our first installation in Hatton-garden, and then at the Liverpool-street railway station, and nearly everybody said how much prettier they might make the arc lamp. Engineers and others who were asked to tender for building the Brush plant and apparatus in nearly every case had some suggestion to make for the alteration of dimension and detail, in order to suit each individual whim. The result was that we were much longer in making progress in England in the introduction of the arc light than they were in America, though I do not wish to infer that this was wholly attributable to this cause, yet it was to this, among others.

Now, what we want in a consulting engineer is a man who can recognise first what is best in the market, best for actual merit, and most suitable for his requirements—a man who can guide those whom he advises in their selection of the best thing for the work to be done, and who will be content to leave matters of constructive detail in the hands of honest manufacturers whose interest and profit shall lie in making a good thing, rather than producing some type or variation of design of which he practically makes only one—and that an unsatisfactory one—instead of many which can grow each in quality through experience in manufacture, and where there is a margin of profit, which in many manufacturing operations is larger in consequence of numbers and output. My remarks refer of course to the immature engineer, and naturally can have no reference to individuals present. Our consulting engineer can be of great help to us if he works conscientiously. He will see that what is undertaken by the contractor is carried out efficiently and well; and I also think it is his duty to see that not only do those who employ him get good value for their money, but also that those he employs get a reasonable margin of profit on their work. This brings me to another and very important point. We find all around us towns, corporations, and companies that are going in for the public supply of electricity. We find a huge new industry in which thousands of pounds of capital are invested. Many of the most advanced minds are at work in developing mechanical and electrical details, and yet we find that, with very few exceptions, nearly every manufacturer who tenders competitively for work says he will be practically without profit if he gets the contract. Now, something is wrong in this. I admit that competition (which, after all, cannot be prevented) has a great deal to answer for, but I think, on the other hand, that many of our consulting engineer friends (and, as I said just now, it is their business to see, they being disinterested themselves) should see that both parties to the bargain, those who buy and those who sell, are taken reasonable care of. It is a curious fact that there are large corporations around us that have plenty of money (that they can borrow at a low rate of interest) buying electrical machinery and plant that barely pays a profit to anyone concerned. And yet these same corporations, acting under the advice of their engineers, would be perfectly willing to pay a fair price. In many cases I have known that engineers' estimates are allowed that would have given a reasonable working profit to all the contractors and undertakers, but these were undercut by the competing firms. I merely mention this here in connection with our consulting friends, who, I am sure, can be of great assistance to us. But the fault is not theirs.

Now, we will pass from the consulting to the constructive engineer. In this class we include both manufacturers and installers, and we may consider these gentlemen from both an electrical and mechanical standpoint. In electrical engineering of to-day—I mean where we are converting heat energy into electrical energy through the medium of dynamos and generators—the mechanical engineer plays an important part, and I am glad to see that the society has among its members many gentlemen who may be said to belong exclusively to the mechanical side. They must, however, in order to justify their membership of a society of electrical engineers, see how closely the union between the electrical and mechanical is growing. It must not be sufficient for them to say that they make an engine that can run at a given speed, and that such engines as they have built have been working in connection with Lancashire boilers in our cotton and other industries here for the last 25 or 30 years. I do not suggest that many engineers say this to-day, but I remember in the early days of electric lighting the man who made a small portable agricultural engine said he had got everything that was required for our purpose, and I remember what difficulties we had in getting these people to see that the requirements of a mechanically-driven dynamo were different from that of driving a thrashing machine. To this engineer, they both went round, and I remember that a man would say that his engine could do such and such work, and could certainly drive that bit of a thing—the dynamo. He would come and watch his engine—the stoker perspiring, the water running down, and the steam running down still quicker—and he would stand and wonder where on earth the power was going to. We have left these days, however, and the mechanical engineer is awaking to the fact that perhaps the biggest field he will have in the future will be in connection with electricity. In a district like this, where thousands of engines are used daily for driving mills, with their miles of shafting and belting, manufacturers are beginning to wonder why they should use such huge engines at times when their loads are light and only part of their works are running, and they have to lose so much in unnecessary shafting and belting, friction, etc. In many places I am glad to say that, following the electric light plant, has come

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the electrical distribution of power plant. Electric motors are taking the place of shafting and wires the place of belting, and I advise our engineer friends to look well to this outlet for their industry during the coming period.

Now, for our electrical, as apart from our mechanical, engineers—the men who by their thought and work have designed our alternate-current dynamos, our continuous-current machines, our multiphase machines, our transformers, our arc and incandescent lamps, our measuring instruments, and the multitudinous accessories. These men must try to get as far as they can from the traditional millinery of the philosophical instrument maker, and must see that they must combine with their electrical requirements the very best mechanical conditions and surroundings. They must also work hand-in-hand with the mechanic. They must get away, as they are doing, from the sealing-wax and brass lacquer, and they must remember that in work of the magnitude that is likely to come on durability is going to play as important a part as efficiency, and they must not sacrifice to efficiency the many other requirements of practical everyday use. I have not intentionally spoken slightingly of our friends the telegraph engineers. Some of my references have only been to those earlier and respected men whose knowledge was necessarily limited to the electrical portion of their work, so that they did not appreciate the conditions of the mechanical portion. I am glad to say that we have among the members of our society those who are interested in telegraphy and telephony. Telegraphy, more especially as relates to submarine work, could be effectively dealt with by one who I regret to see is not here to-night—I mean our respected member, and one of our founders, Mr. George Preece; but that being a branch in which the assembled members take little interest, I will not refer further to it. Telegraphy, I may say, seems to be a completed and perfected branch, which may probably continue to grow in bulk, but which will more probably be more or less supplanted by telephony, which has made giant strides during the last few years. Among telephone engineers large and important problems have to be worked out. An ever-increasing number of subscribers means an ever-increasing difficulty in wayleaves and communications. I have no doubt that we shall receive in the future interesting papers from gentlemen connected with this branch, and they will be able to point out to us how they have overcome both their mechanical and electrical difficulties. They will watch with jealousy the introduction of those large power systems for fear of interference by induction and other causes, and engineers will do well to consider here in concert with one another how they can each give and take, how they can each learn something of the conditions and requirements of the other without experiencing either annoyance to themselves or interference with public requirements.

Our telephone engineers must not think that they "own the earth" because they happen to have been born first; nor must our electric traction friends think that because they wish to come in as well they can ruthlessly remove all existing systems. There has been during the last few months an animated discussion with regard to these matters, and if the discussion necessary for the removal of these difficulties can be carried on here by papers and debate, I have no doubt that those will be among the things that will justify the existence of this society. We shall have in the near future an enormous advance in connection with electric traction. In 1883 I was interested in being asked by the Blackpool Winter Gardens Company if I could run a small electrical carriage. I placed this in the hands of my friend Mr. Holroyd Smith, of Halifax, who afterwards constructed the Blackpool electric tramway; and it is interesting to see that since that date till practically within the last 12 months there has been comparatively no advance in this country in connection with electric traction. On the other hand, in 1885 I was in America, and was there interested in the pioneer company—the Bentley-Knight. I went out to Cleveland to see the experiments in electric traction, and since then (1885) to the present moment (January, 1895) there has been such an advance that there are now 9,000 miles of electric tramway track, as against 4,000 miles of horse tramways; 20,000 electric cars are run, and hundreds of thousands of horse-power are employed in driving the electric plant. And the capital invested amounts to 225,000,000dol. (£45,000,000). Now, one reason, among others, why we have been held back so much has been the miserable petty jealousies among our own engineers, among men who ought to know better, who would rather that the work of construction should go to America than that it should be done by an old competitor and countryman. Of course in these remarks I have no reference to the members of the Northern Society of Electrical Engineers, for fortunately they have not lived long enough to have a history of this kind. I wish this society to avoid these petty jealousies. On several occasions on which I have had the honour to address you I have referred to questions of this kind.

And this brings me now to my installing engineer. It is somewhat difficult to define an installing engineer or contractor. I believe that every man who can use a piece of cotton-covered wire, a pair of pliers, and a soldering iron, describes himself as an electrical engineer. We do not want to give limitations to the aspirations of the man who begins at the bottom of the ladder with his wire and pliers, but we do want to give limitations that will secure reasonable productive profits to a business that ought to be carried on well, and not subject to the ceaseless and unnecessary cutting competition that we experience. In our installing engineers we ought to have men who have the interests of their work at heart. They have to go into buildings and instal their system of wires and cables, making them as little obtrusive as possible, and to take care that there is the least interference with the carrying out of the ordinary work that is being done in those buildings. Now they have to do, or ought to do, honest work, but I have unfortunately seen many cases in which a competent firm has determined to go for a job and get it at any price, and has then endeavoured to do as little as possible in order to try and do the work at somewhere near the contract price. In the old days we used to get 40s. a light, or point. I do not say that this was not too high, but when we come down to 7s. 6d. a point, either the people in the old time made an outrageous profit or the people in the present time do work that cannot be justified. There is, I am afraid, a tendency for a great deal of "eye service" in this. As long as the switches will turn on the current to the lamps, and no questions be asked as to the condition of affairs between the dynamo and the lamp, or the wires, joints, and cut-outs, some people are satisfied, always provided they can get their bills paid. But, after all, this is a very short-lived policy. We must not bring our business into disrepute by cheap and ineffective work. I recollect in America that a manufacturer of cotton goods told me that he had had a large enquiry and was doing a considerable business in China, and that he believed some of his cottons were being imitated and sold under a similar mark by Manchester houses, which, while he considered it very flattering, was a great surprise to him till he looked into it. I myself looked into the question, and found that in this district of Manchester there had been a practice of dressing or loading cottons with certain mineral substances and earths in order to give an attractive finish and heavy weight, and which could be sold to the unsuspecting foreigner at a much greater profit in close competition, because it was naturally considerably cheaper to load with earth than with cotton. These goods were sent out to China, and poor John Chinaman and his friends discoyered that the first shower of rain, instead of glancing harmlessly off his clothes, washed away all the earth in his cotton suit, and left him practically enveloped in a sieve. The Chinese then found that the practice of loading cotton had not then been extended to America, in spite of the proverbial "'cuteness" of the Yankee, because, owing to his protective tariffs and other conditions, the American manufacturer was able to make a reasonably good article and sell at a comfortable price, and although they commanded a higher value in China they were preferred to the English article. Thus the Manchester goods got a bad name difficult to recover, and the American got in as maintaining his quality. Now, I am not addressing you as generally being in the Manchester trade, but as we happen to live and work in this district, let us be warned by the mistakes of others and take care not to commit them ourselves.

Now, then, to you contractors. See that your work is well done. See that your work can pass muster by our friend the consulting engineer, and by our esteemed friend Mr. Heaphy and other representatives of the fire insurance offices! If you do your work honestly and well, you will find that it will pay you. You will be able to say that for work bearing the reputation of your name you must have a certain price, and let the men who want to cut, cut, and do as bad work as they please. They will soon either go right out of the trade or find it is useless to do bad work for nothing. They will see the folly of their ways, and do better work at a profit. It must not be left (as is unfortunately too often the case) to contractors to say, "Well, we do not mind what we get for the work as long as we can vary the tender. We can then make our profit on the extras." This, gentlemen, to my mind is not right.

Now, I have gone carefully over the different interests of the society. I have tried to call your attention to our individual selves, and now I want to look at ourselves collectively. As we have seen, we have grown during our first year rapidly and satisfactorily. But it is not sufficient that we should grow simply in numbers. I said that, in addition to the practical and technical objects of our society, we had another one, the social element to consider. If this body poses as a purely scientific society, which it evidently does not, we might, in the regions of pure science, almost feel that we could ignore social considerations. But as the bulk of our members are eminently practical, our social relations to each other become important; and it is here I think that this society has a large field for usefulness, and I should say that the introduction of dinners, smoking concerts, excursions, and other social gatherings, if judiciously carried out, may be found to be a most useful thing for us all. When men in similar pursuits only meet each other from a business point of view, they are apt

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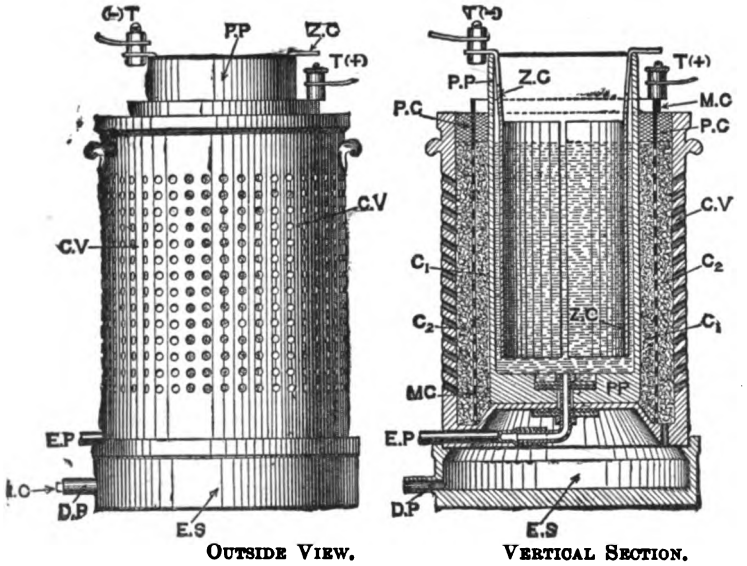
to see each other to the worst advantage. I am glad to say that men whom I once did not care to meet because our interests were conflicting have on further acquaintance been those I honoured and respected most. You will probably find this to be the case here; and if, instead of the manifold petty jealousies that are apt to be fostered among members of the same profession, you will get into an inner or family circle, recognising that you are members of the same family and have an equal right to live and let live, and that by good feelings of brotherhood and give-and-take, and not each one going for himself, you may be able to do a vast amount of good in the future. How often would it be useful for men to honestly and honourably get together to discuss certain points and questions of prices, policy, and quality of work, rather than only know the price when tenders come out and the quality when the work is done. It is not as though there were not enough work for all. The extension of the electrical industry is practically unlimited. Lighting, traction, telephony are yet, comparatively speaking, in their infancy. And when we come to such things as electrical transmission of power, electro-deposition, electro-chemistry, electric welding, heating, cooking, and smelting, we can see the field that can be practically and profitably occupied by everyone connected with this industry. But in order to occupy this field well we must have a proper recognition of the rights of each other, and I trust that you will receive the remarks that I have made in this address and apply them practically to yourselves. I trust that you will not consider that I have taken advantage of my position as president to give an address which is not to be discussed, and which may appear to be rather in the nature of a homily than of a technical discourse. The scientific and technical discourses must come along in the future. My only wish is to endeavour to lay a proper foundation on which the structure can be built, and I wish it to be that in 10 years time, when you hear your then president address you, that those there present may look back with feelings of gratitude and pride to the time when they first became members of the Northern Society of Electrical Engineers.

THE "WALKER-WILKINS" NON-POLARISING BATTERY.

We have received for publication the following report by Prof. Andrew Jamieson, M.I.C.E., F.R.S.E, on the above battery:

Having received from you specimens of your non-polarising cells, with a request to test and report upon the same, I have much pleasure in stating that I consider them symmetrical in form, substantial in every detail, and thoroughly well made; besides which they have proved very efficient (chemical) generators of electrical energy. As will be seen from the following drawing and index to parts, your cell is composed of an amalgamated split

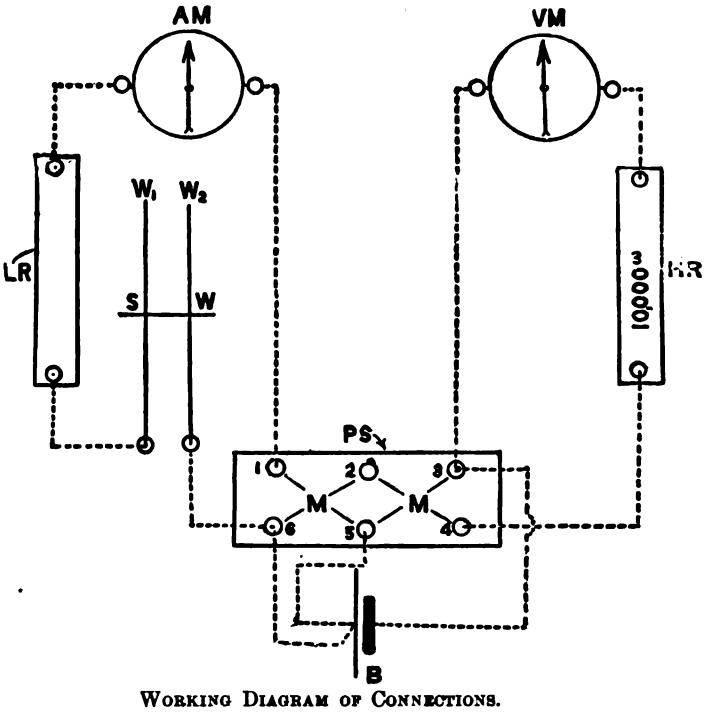


OUTSIDE VIEW. VERTICAL SECTION.

Index to Parts.—T (-), negative terminal; Z C, zinc cylinder; P P, porous pot; P C, pitch covering; C_1, carbon (powdered); C_2, carbon (granular); M C, metal cylinder; T (+), positive terminal; C V, containing vessel; E P, emptying pipe; D P, drain pipe; I C, indiarubber corks; E S, earthenware stand.

cylinder of zinc immersed in a solution of caustic potash, contained in a porous pot, placed concentrically within a larger perforated outer vessel. The space between these vessels is packed with carbon, the carbon in contact with the porous pot being powdered, while that next the outer vessel is granular. The current is collected by means of a perforated nickel cylinder embedded in the granular carbon.

Advantages.—The advantages which you claim for this cell are (1) freedom from offensive or obnoxious fumes when working; (2) the simplicity of the cells and of the charging solution; (3) the almost entire absence of local action, and unnecessary waste of zinc. I am glad to be able to corroborate these three claims. You also say that the cells have been introduced to meet the long-felt want of a reliable primary cell which does not polarise, and which keeps a constant current up to a certain rate of output. The following tests and curves will enable anyone who understands this important subject to judge how far your aims have been accomplished. The following diagram shows the arrangement of the testing connections:



WORKING DIAGRAM OF CONNECTIONS.

Index to Parts.—B, battery or cell under test; P S, paraffin switch; M M, mercury contacts; A M, ammeter; V M, voltmeter; H R high resistance (10,000 ω); L R, low resistance; S W, slide wire; W_1 W_2, wires for variable slide resistance.

TABLE I.—WEIGHTS AND DIMENSIONS.

Two-pint size.	Weight charged.	Dimensions.
No. 1	19lb. 3oz.	Total height.
No 2	19lb. 5oz.	Including stand.
No. 3	19lb. 1oz.	14in. × 8¼in. diameter

THE TESTS.

(1) *Potential Current—i.e.*, the variation of the potential difference at the terminals of each cell due to the variation of the current strength in its external circuit.

(2) *Total Output in Ampere-Hours—i.e.*, the cell was allowed to discharge through a resistance so varied as to keep the current constant.

(3) *Recuperativity—i.e.*, the rise of E.M.F. after being short-circuited through a copper voltameter for two days. The output in ampere-hours being measured by the weight of copper deposited in the voltameter.

(4) *Internal Resistance* as calculated from the results of Test 1 given in Tables II. and III.

Two galvanometers were used, as shown in the preceding diagram of connections, one of very high resistance as a voltmeter, and the other of very low resistance as an ammeter. The high-resistance galvanometer was so controlled as to give a deflection of one scale division for 0·0044 volt. A "Latimer Clark's standard cell" (of 1·454 volts at 15deg. C.) produced a deflection of 330 scale divisions. Consequently, one scale division $= 1 \cdot \frac{4}{330} = 0044$ volt. The low-resistance galvanometer was under strong magnetic control, and shunted by a short thick copper wire. It was then carefully calibrated to read in milliamperes.

TABLE II.—POTENTIAL CURRENT TESTS. (For Cell No. 1.)

Current in amperes.	P.D. in volts.	E M.F. at end of each five minutes.
·000	—	1·457
·156	1·317	1·343
·228	1·305	1·334
·294	1·302	1·328
·371	1·290	1·324
·425	1·283	1·324
·467	1·272	1·324
·545	1·244	1·317
·778	1·231	1·311
1·000	1·216	1·290
1·241	1·199	1·285
1·346	1·049	1·264

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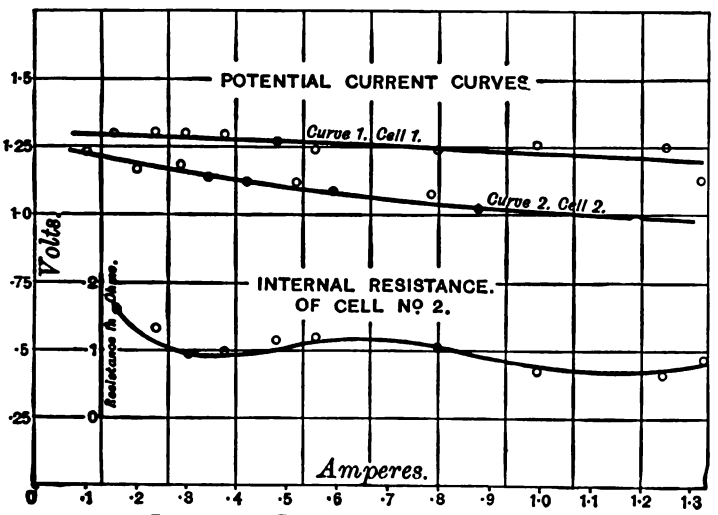
The preceding table shows the results of test No. 1, or that of the potential current test. The cell was joined up as in the preceding diagram, and its E.M.F. measured. A current of a certain value was then obtained from it for each period of five minutes. At the end of each such period the potential difference and current were simultaneously noted. The external variable resistances (L R and W_1 W_2) were then reduced, so that the current was increased until it had risen from 0·156 ampere at the beginning to 1·346 at the end of the tests. Eleven readings were thus obtained from cell No. 1.

The same test again was made with another cell—viz., No. 2.

TABLE III.—POTENTIAL CURRENT TESTS. (For Cell No. 2.)

Current in ampere.	P.D. in volts.	E.M.F. at end of each five minutes.
·000	—	1·371
·100	1·229	1·244
·205	1·180	1 227
·290	1·152	1·207
·348	1·137	1 196
·422	1·123	1·185
·520	1·105	1·182
·590	1·087	1·176
·783	1·052	1·170
·870	1·023	1·164

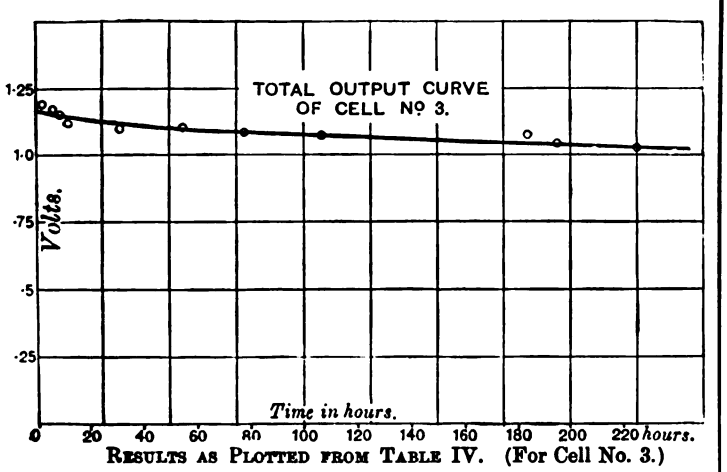


RESULTS AS PLOTTED FROM TABLES II. AND III.

TEST II.

TABLE IV.—OUTPUT IN AMPERE-HOURS. (For Cell No. 3.)

Time in hours.	Current in amperes.	P.D. in volts.
0	1·1	1·173
·16	1·1	1·171
·33	1·1	1·169
·50	1·1	1·168
3·00	1·1	1·152
7·5	1·1	1·145
12	1·1	1·124
31·1	1·1	1·115
55	1·1	1·102
78·75	1·1	1·085
112	1·1	1 079
184	1·1	1·059
188·5	1·1	1·029
226·5	1·1	1·015



RESULTS AS PLOTTED FROM TABLE IV. (For Cell No. 3.)

The gain in the voltameter plate was 292 628 grammes, which gives an output of 250 ampere-hours.

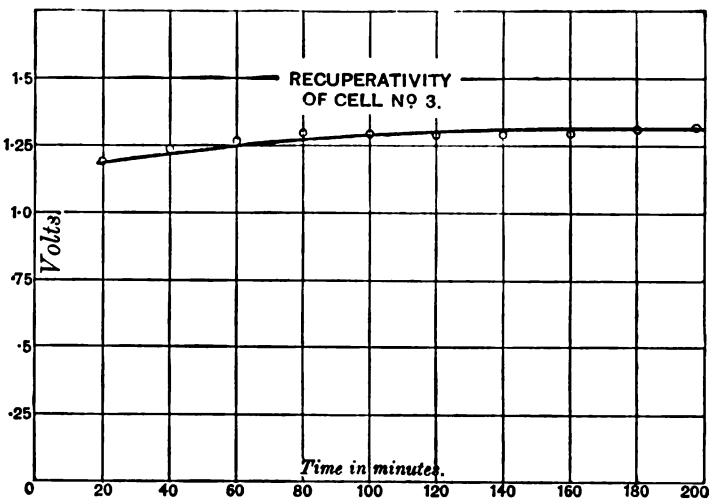
Weight of zinc used	·69lb.
Theoretical weight of zinc required for the above output was only	·671b.

This gives the very high efficiency of 97 per cent. This result is better than that of any primary cell I have yet tested.

RECUPERATIVITY.

TEST III. TABLE V. (For Cell No. 3.)

Time in minutes.	E.M F. in volts.	Time in minutes.	E.M F. in volts.
20	1 191	120	1 285
40	1 236	140	1·289
60	1·260	160	1·293
80	1·281	180	1·318
100	1 283	200	1·328



RESULTS AS PLOTTED FROM TABLE V.

TEST IV.—INTERNAL RESISTANCE.

The potential difference at the end of each period of five minutes was deducted from the total E.M.F. at the end of each period. This gave the fall of voltage or pressure inside the cell. Then this internal voltage or fall of potential inside the cell, divided by the current at the time, gave the apparent internal resistance of the cell.

$$\text{By Ohm's law, } C = \frac{E}{R} \quad \therefore \quad r = \frac{E - (P.D.)}{C},$$

where r represents the internal resistance of the cell (see curves). From this formula (as calculated from Tables II. and III.) the mean internal resistance of the two battery cells were 0·112 and 0·161 ohm respectively.

TEST V.

Having also received from you a specimen of your combined three-cell oval type, with a request to test the same, I have much pleasure in stating that in all respects it has proved as satisfactory as the previous ones. This battery consists of a combination of three cells, joined in parallel. Each cell, however, is similar in internal construction to those already described, but the carbon of each cell is surrounded by a thin perforated metal cylinder instead of the earthenware containing vessel, while another oval perforated vessel of the same material surrounds the three cells. This greatly reduces the weight for a given output. The total length, including the insulated handles, is 21in. by 5½in. broad and 11in. high, the weight being approximately 30lb. Each set of three cells is intended to give a current of six amperes at about one volt potential difference.

TABLE VI.—TOTAL OUTPUT. (For the Three-Cell.)

Time in hours.	Current in amperes.	P.D. in volts.
0	6·1	1·145
1	6·1	1·140
18	6·0	1·134
19	6·0	1·134
22	6·0	1·134
24	6·0	1·130
42	6·0	1·122
44	6·0	1·122
48	6 0	1·110
72	6·0	1·090
76	6·0	1 072
77	6·0	1·042
95	6·0	1 022
97	6·0	1·022
102	6·0	1 020
104	6·0	1·020
125	6·0	1·010
128	6·0	1·000

My first test gave an output of 324 ampere-hours with a very small diminution of voltage, but after this output the cell was allowed to run down by mistake, between a Friday night and Monday morning, and thus the exact total output could not be ascertained. The same cell was, however, then cleaned out and freshly charged with your caustic solution, whilst the zincs were carefully re-amalgamated. A copper voltameter was placed in circuit, and the cell again started. A Weston standard voltmeter and a milliampere-meter were placed in circuit, and readings of

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the current and potential difference were simultaneously noted throughout the trial.* The results were as shown in Table VI., which shows that the cell kept a remarkably constant current with a slight fall in voltage. I have therefore much pleasure in affirming that your non-polarising cell is the best of its kind that I have ever tested. I believe that it will prove very serviceable for driving electric motors, for electric lighting, and for the electro-deposition of metals, where engines and dynamos are not available. Finally, I have pleasure in thanking my assistant, Mr. David A. Ramsay, and two of my students, Messrs. Stephen Hutchison and Alexander Nisbet, for their kind assistance and perseverance in arranging and taking the many readings, which these long continuous tests involved.

PHYSICAL SOCIETY.

An extra meeting of this society was held on November 11, 1894, in the physical laboratories of University College (by invitation of Prof. Carey Foster), Prof. Rücker, president, occupying the chair.

Prof. Ramsay read a paper, by himself and **Miss Dorothy Marshall**, on "**The Measurement of Latent Heats of Vaporisation of Various Organic Liquids.**" The liquid to be examined is placed in a small flask with a narrow neck, and within this is a platinum wire, which has its two ends fixed through the bottom so as to be capable of conveying an electric current and thus giving heat to the liquid. The flask is completely enclosed in a jacket, which is filled with the vapour of liquid of the same kind kept briskly boiling in a somewhat larger flask. Before the current is turned on the vapour jacket is kept going for some time, so that the liquid in the flask is raised just to its boiling point, but no appreciable evaporation takes place. As soon as the current is turned on boiling commences, and as the temperature of the liquid cannot be further raised all the heat developed in the wire is expended in producing evaporation. By weighing the flask before and after, the mass of liquid vaporised is determined. So far the authors have only used the method for comparative determinations. Two arrangements of the kind described are placed side by side, and the same current is sent through their two wires, which are joined in series, and have approximately equal resistances. The actual values of the resistances are found while the current is flowing, and allowance is made for their inequality. The ratio of amounts of heat expended on the two liquids, divided by the ratio of the masses vaporised, is equal to the ratio of their latent heats. As a standard liquid of known latent heat, the authors prefer alcohol to water, as it vaporises more easily and with less bumping. The determinations made by this method agree well with those of other observers, but the authors' object is to obtain values correct within about ½ per cent. for a large number of liquids rather than a highly accurate value for any one substance. In reply to **Mr. Griffiths**, the authors stated that the platinum wire was found to rise about 20deg. above the temperature of the liquid, and Mr. Griffiths said that his experience had been similar. He did not see why a very high degree of accuracy should not be obtainable by the method. **Prof. Rucker** expressed his admiration for the work, and thought it justified by the fact that the results accorded more nearly with theory than those of other observers.

Mr. Rumorfopoulos read a paper on "**The Determination of Thermal Conductivity and Emissivity.**" In the first series of experiments described, two bars of the same material and polish, and each of uniform circular section, are heated, each at one end, until the distribution of temperature has become steady. By means of two thermo-joints (one on each rod) a series of isothermal points are then found. According to the ordinary theory, if the two bars agree in temperature at a given pair of points, they will also agree in temperature at distances x_1 and x_2, measured respectively from these points, where x_1 and x_2 are connected by the relation $x_1/x_2 = \sqrt{(r_1/r_2)}$, r_1 and r_2 being the radii of the rods. This relation was not found to hold good for the rods examined, some being of brass, others of copper and of German silver. In all cases x_1/x_2 was further removed from unity than the ordinary theory would require. One conclusion was that the formula usually adopted in such cases could not be used for the comparison of conductivities unless the radii of the rods compared are equal, and their surfaces in the same condition, for it seemed unlikely that the thermal conductivity of the smaller of each pair of rods was less than that of the thicker one. To settle the question, three brass rods were chosen, and their absolute conductivities compared by Angström's method, one end of the rod being alternately heated and cooled, and the alternations of temperature observed at two points along the rod as soon as they had assumed a periodic character. At each point of the bar the excess of temperature over surroundings may be analysed into a Fourier's series, consisting of a constant term and series of sines and cosines. Hence both emissivity and conductivity were calculated. The emissivity was found to vary considerably with the radius, being greater the thinner the rod; moreover, the value of the emissivity deduced from the first sine term of the Fourier's series was in each case found to be about 1·2 times as great as that deduced from the constant term.

Mr. G. U. Yule then gave a brief outline of his paper "**On the Passage of an Oscillator Wave-Train Through a Plate of Conducting Dielectric.**" By a conducting dielectric the author means a substance whose conductivity and dielectric capacity are both of importance in the case under discussion, and the paper is mainly an investigation of the following problem: a train of plane electromagnetic waves falls at normal incidence on an infinite parallel-sided plate of conducting dielectric, whose thickness is finite, and at the first face of the plate the amplitude of the vibration-vector in the incident train is zero up to a certain instant, and then becomes equal to an harmonic function of the time, multiplied by an exponential function with negative index. To find what proportion of the energy of the whole incident train is reflected back, what proportion is transmitted through the plate, and what proportion absorbed at successive incidences of reflected and re-reflected wave-trains upon the two bounding faces of the plate, the amplitudes and phase-changes of reflected and transmitted portions have to be taken into account, and the resulting infinite series of terms have to be summed. The analysis is very long, but the results obtained are exact. Curves are given, showing (for special numerical values of the constants of the problem) the quasi-periodic variation of the amounts of energy transmitted and reflected, as the thickness of the plate is increased from zero up to a high value. Other curves are given showing the effect of varying the dielectric constant and the conductivity of the plate, and the difference between a "damped" and an "undamped" wave-train in regard to intensity of reflected and transmitted portions. The author compares his calculated results with measurements obtained in the case of oscillator waves travelling along a double-wire circuit about 100 metres in length, the wires at the middle of the circuit being run through a jar containing distilled water, alcohol, or a very dilute electrolyte. The necessary corrections, however, are difficult and uncertain, and the author has not found it possible to deal with them in a satisfactory way.

A letter from **Dr. E. H. Barton** was read, emphasising the necessity for taking into account the damping in the oscillator train, and at the same time pointing out why, in his opinion, the corrections applied by Mr. Yule were inadequate and failed to yield intelligible results.

Prof. Rucker congratulated Mr. Yule on his work and on the importance of the results he had obtained. In returning the thanks of the society to Prof. Carey Foster for the invitation to meet in University College, he expressed the pleasure he had felt in observing the extent and completeness of the laboratories. Hitherto London had been behind the provinces in this matter, and it was gratifying to find that students in London had now such opportunities for practical instruction in physics. The papers which had been read at that meeting were a proof that good use was being made of the laboratories for the purposes of research. The educational experiments they had seen in the laboratories were excellently devised, and he hoped that many of them would become a part of the regular course of instruction in the country.

Prof. Foster briefly replied.

SPECIAL REPORT OF THE BOARD OF TRADE UNDER SECTION I. OF THE ELECTRIC LIGHTING ACT, 1888.

The following report, dated May, 28, 1894, has been issued from the Board of Trade by Mr. Francis J. S. Hopwood, assistant secretary:

The Holloway Electricity Supply Company, Limited, applied for a provisional order in respect of the borough of Guildford. The Corporation, who are the local authority under the Electric Lighting Acts, consented to the application on condition that the order should contain a provision authorising them to purchase the undertaking within six months from the expiration of 10 years from the grant of the order, or within six months from the expiration of any subsequent period of five years on the terms specified in Section 2 of the Electric Lighting Act, 1888. The order, when deposited, did not contain a provision to this effect, and the Corporation objected to it, and stated that they were considering whether they should not adopt measures for supplying electrical energy themselves.

The promoters contended that the conditions asked for by the Corporation were unreasonable, and would prevent them from raising the necessary capital for the undertaking, and asked the Board of Trade to dispense with any further consent of the Corporation, and to grant the order in the usual form, or with such modifications of the statutory conditions of purchase as the promoters could agree to. Before deciding whether the application should be proceeded with, the Board of Trade invited the representatives of the Corporation and the promoters to attend at this office to discuss the matter. A meeting was held on March 31, at which the Mayor of Guildford and the town clerk, who attended on behalf of the Corporation, stated that the Corporation desired to retain in their own hands the right to supply electrical energy to the town, but that they had several public works on hand, and were not prepared to apply for a provisional order at present or to place any limit on the time within which they would apply. They stated that the Corporation would, however, consent to the grant of the order on the conditions originally agreed to by them.

The representatives of the Corporation were informed that as the Corporation were not prepared to give any undertaking as to

* The Weston meters had been most been most carefully compared with Lord Kelvin's latest standard balances and found to be correct.

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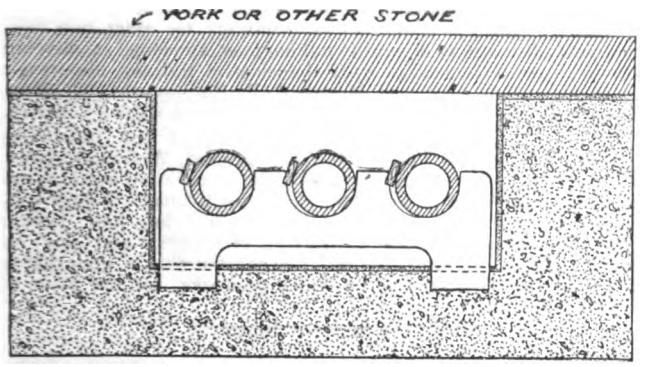
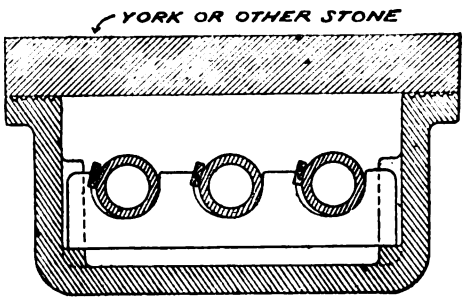
the period within which they would apply for an order, the Board of Trade would not be justified in refusing to proceed with the promoters' application. The Board were unable, however, to impose on the promoters the condition as to purchase asked for by the Corporation, which appeared to them to be an unreasonable modification of the terms established by Parliament, but they intimated their readiness to consider any further proposals the Corporation might submit. Subsequently, the Corporation suggested that the period at which the option of purchase on the terms of Section 2 of the Electric Lighting Act, 1888, should arise should not exceed 30 years.

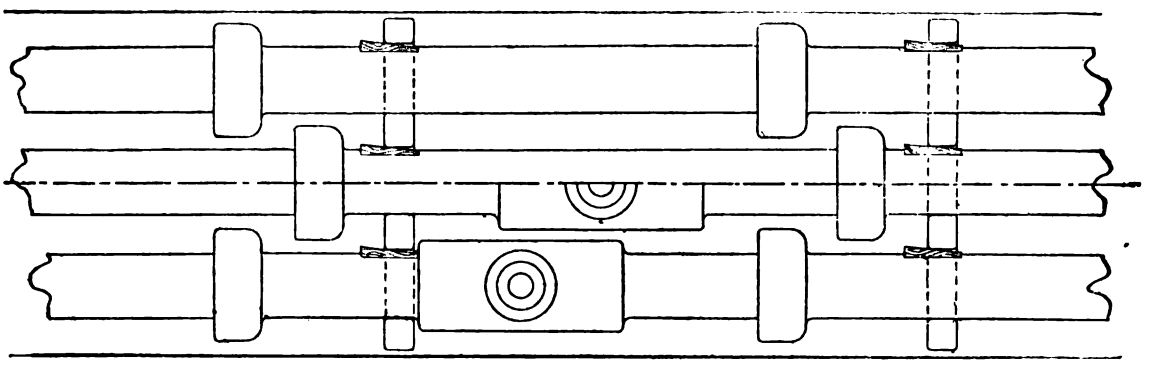
The promoters were unable to accept this proposal, and urged that a reduction of the statutory term was not reasonable without some corresponding concession on the part of the purchasing authority. On the suggestion of the Board of Trade, however, they agreed to accept a provision that the period of 42 years fixed by the Electric Lighting Act, 1888, should be reduced to 35 years, and the Board of Trade decided to grant the order on these terms. This decision was communicated to the Corporation, with an intimation that the Board of Trade would be glad to hear that they were prepared to give their consent. The Corporation, however, replied that they were not prepared to consent to the grant of the order in the form proposed.



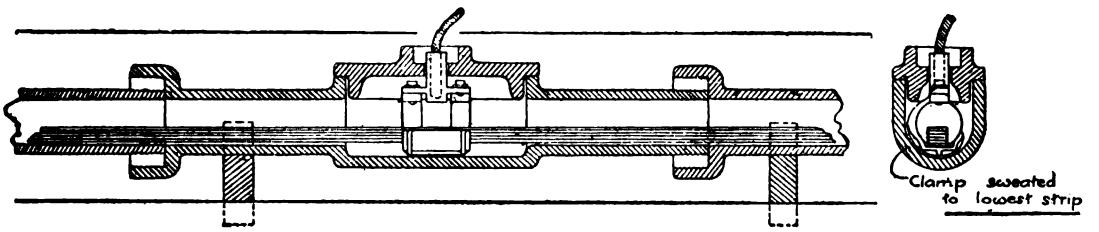
The Spence-Doulton System in Concrete Culvert.



The Spence-Doulton System in Earthenware Culvert



Plan of Culvert.



Sections of Junction-box, showing Method of Making Branch Connections.

THE SPENCE-DOULTON CONDUIT.

In the accompanying illustrations is shown a new type of conduit designed for the reception of bare copper mains. It will be noticed that the principal object in view has been to combine the advantages of the drawing-in system with those accruing through the use of copper strip laid in culverts. The conduit, as will be seen from the cross-sections, is composed of vitrified stoneware tubes, carried on insulating bridges of the same material, and laid in a culvert or trough. A special type of joint which does not necessitate the use of cement is used, this being to all intents and purposes an artificial "bored and turned joint." This joint is watertight, and surface leakage is thereby prevented. A plan of the conduit showing straight pipes and junction-boxes, and sections of the junction-box representing the method of making branch connections, are annexed. This method of underground conduits has been introduced by Messrs. Doulton and Co., of Lambeth, S.E., who state that, in addition to the insulation afforded by the tubes, the bridges form a further safeguard, thus ensuring a high insulation resistance. The company claim that this system allows additional copper strips being laid down with greater facility than that of drawing insulated cables into cast-iron pipes; that existing conductors do not need to be hauled out before new ones can be drawn in; and that as there is no insulation coating to be abraded, or to weight the strip, the surface boxes may be arranged further apart than is the case where insulated cables are employed. As regards service connections, the junction-boxes, as shown, are simple, and they can be placed at small cost opposite every alternate party wall. If, however, a connection is required where no provision has been made, it is only necessary to remove a short length of the pipe and replace it with a modified one. The company supply earthenware troughs for the accommodation of the conduit. These troughs, which can be more rapidly constructed than those of concrete, are fitted with socket joints for Portland cement, and are provided with lugs for keeping the bridge insulators in position.

ELECTRIC LIGHTING IN THE CITY OF LONDON.

The directors of the City of London Electric Lighting Company, Limited, have decided to allow discounts to customers in accordance with the following scale:

5	per cent. off an account amounting to.....			£100
7½	,,	,,	,, ...	200
10	,,	,,	,, ...	400
12½	,,	,,	,, ...	550
15	,,	,,	,, ...	700
17½	,,	,,	,, ...	850
20	,,	,,	,, ...	1,000

The accounts will be issued, as hitherto, at 8d. per Board of Trade unit, and the discount under the above scale will be allowed in those rendered for the last quarter of the year, provided the account for each quarter is paid within one calendar month from the last day of such quarter, and no consumer will be entitled to any discount until he has been supplied for a complete year from January 31 to December 31. A consumer connected to

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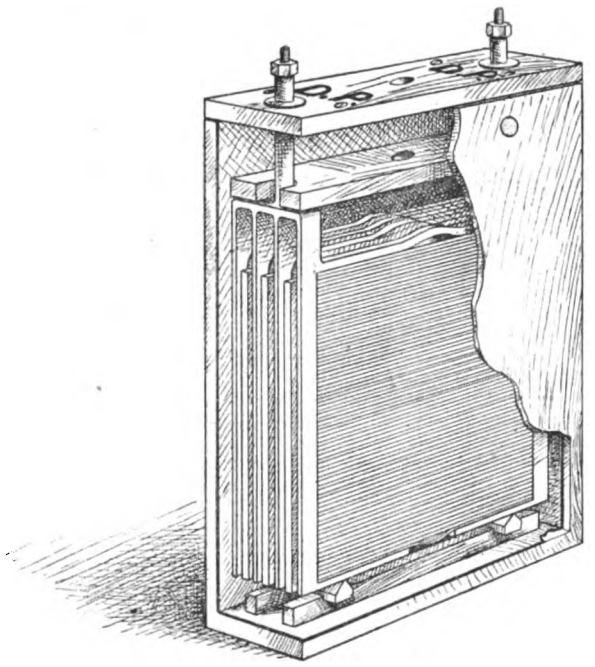
the Company's mains at any date between January and December will not be allowed discount until after the expiry of 12 months, dating from the following December 31 after his connection. He will then receive discount, based upon his annual consumption, for the whole time he has been connected. A customer taking current for less than 12 months will not be entitled to any discount. Each tenancy in a building is to be treated as a separate consumer.

The rate for current for lighting at night (between the hours of 10 p.m. and 6 a.m.) and for motive power, heating, and cooking purposes will remain for the present 4d. per Board of Trade unit, and will not be subject to the above scale of discounts. The Board have also authorised the following reduction in the quarterly rental of meters: up to 50 lamps of 8 c.p., from 5s. to 2s. 6d.; above 50 lamps, for every additional 50 lamps or part of 50 of 8 c.p., 2s. 6d.

The above alterations take effect as from 1st inst.

TRAIN-LIGHTING BY STORAGE BATTERIES.

The lighting of railway trains by means of storage batteries has been more generally introduced on the Continent than in this country, and we are now glad to learn that Messrs. Johnson and Phillips are moving in this direction. The firm, who have been encouraged by the great success of the "D. P." battery during the last five years, are now bringing out an adaptation of it for train-lighting. The new cell is shown in the illustration, and its features, compared with other well-known types, are smallness of space occupied, reduced weight, large space between the plates (preventing short-circuiting and collapse of cells), and great mechanical strength and high efficiency.



These qualities, combined with the well-known advantages of the battery in point of durability, render it specially suited for train-lighting work. The particular cell represented in the illustration is the "B" size; 220 ampere-hours capacity, the outside dimensions being 6½in. by 10¾in. by 17¾in. high, and the weight 92lb. These cells are produced by a special electrolytic process, which is entirely free from any patents held by other makers.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Saint-Dié (Vosges, France).—The Municipality invite tenders by February 1 for the concession for a central electric light station for the town.

Louvain (Belgium).—Tenders are invited by February 1 by the local authorities at the Hotel de Ville for a concession for an electric tramway from the railway station to the Grand Place, Louvain.

Bristol.—Tenders are invited for the installation of the electric light at the Guildhall and a portion of the Council House, for the Corporation. We have already given particulars. Tenders must be sent in by to-day.

Nelson.—Tenders are invited for lighting Stanley-street Chapel, Nelson, by electricity. Particulars are obtainable from Mr. James Bateson, 10, Primrose-street, Nelson, to whom tenders are to be sent by to day.

Lisbon.—Tenders are invited by 31st inst for telegraphic apparatus and porous jars by the Royal Portuguese Railway Company, of Lisbon. Particulars are obtainable from the bureau of the Compagnie Royale des Chemins de Fer Portugais, 28, Rue de Châteaudun, Paris.

London.—The Metropolitan Asylums Board invite tenders for the supply and running of mains, and the wiring of the buildings and grounds of the North-Western Fever Hospital, Haverstock-hill. We have already given particulars. Tenders are to be delivered not later than Thursday, the 24th inst.

RESULTS OF TENDERS.

Coventry.—The City Council have accepted the tender of Messrs. Chamberlain and Hookham, Birmingham, for the supply of meters.

Hampstead.—The Vestry have accepted the tender of Mr. Frederick H. Taylor, at £68, for fitting up buildings in the stone-yard for the electric light.

Broadhembury.—The tender of Messrs. Hearden and Son, of Plymouth, has been accepted for fixing a lightning conductor to Broadhembury Church, near Honiton.

Aberdeen.—The tender of Messrs. New and Mayne for wiring, for electric lighting, the Municipal Buildings, for £200, has been accepted. For supply of additional engines, dynamos, steam and exhaust pipes in connection with the electric lighting station in Cotton-street, the tender of Messrs. J. H. Holmes and Co., Newcastle-on-Tyne, at £3,270, has been accepted by the Town Council.

Walsall.—The Town Council have accepted the following tenders—viz., one by Thomas Parker, Limited, Wolverhampton, for supplying plant (except mains) for the generating station, for the sum of £5,061; one by the Callender Bitumen, Telegraph, and Waterproof Company, London, for supplying and laying down the electric mains, for the sum of £3,998; and one by Mr. H. Gough, Wolverhampton, for constructing a generating station at the Wolverhampton-street gasworks, for the sum of £1,750.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,924.

The Electrophone, Limited.—Letters of allotment and regret have been posted by the Electrophone, Limited.

Lancaster.—The committee of the Central Conservative Club, Church-street, have lighted the club premises by electricity.

Bury.—The Town Council will apply to the Local Government Board for powers to borrow £30,000 for a central electric station.

Lambeth.—The Vestry have decided to thoroughly go into the question of electric lighting, in order to see how the matter stands in the parish.

Worcester.—Mr. Ruthven Murray, of the Aberdeen municipal electric light station, has been chosen as electrical engineer to the Worcester Corporation.

Bristol.—The Electrical Committee have held a meeting, at which Mr. Hill was appointed third assistant engineer, in the place of Mr. Bell, resigned.

Waterloo and City Railway.—The second half-yearly general meeting of this Company will be held at Waterloo Station on Thursday, February 7, at 2.30 p.m.

Direct United States Cable Company.—Payment is announced on the 26th inst. of a quarterly interim dividend of 2s. per share, £3,000 being placed to reserve and £1,807 carried over.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 13th inst. amounted to £866, as compared with £665 in the corresponding week of last year.

Ferranti Alternator.—A 1,000-unit alternator, to give 100 amperes at 10 000 volts, has just been ordered of Messrs. S. Z. de Ferranti, Limited, by the London Electric Supply Corporation.

The City.—The accounts of the City Commissioners of Sewers show that in the year ended September 29 £13,052. 12s. 11d. was paid to the City of London Electric Lighting Company for public lighting.

Brighton.—The question of lighting the Marine-parade by electricity came up again on Thursday (yesterday) upon a letter from Councillor Blaker requesting the committee to reconsider the matter.

Protoria.—For attending to the arc lamps in the public thoroughfares, three of Heathman's patent Brighton pattern wheeled extension ladders have just been ordered to be shipped to South Africa.

Blackrock (Ireland).—A communication has been received by the Blackrock Commissioners from the electric tramways company stating that they would commence the laying of their new line on February 1.

Queenstown.—A proposal is on foot that an electrical engineer should be engaged to report on the practicability of using the present pumping-engine machinery in connection with a scheme for lighting the town electrically.

Bangor (Wales).—In reference to the Electric Lighting Acts, the clerk to the Town Council, as requested by the committee, has prepared a report, which has been ordered to be printed, and copies are to be supplied to the members.

Huddersfield.—In moving the minutes of the Electric Lighting Committee at a meeting of the Town Council on Wednesday, Mr. Calvert stated that the number of consumers had increased from 89 in January, 1894, to 214 in January, 1895.

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Fareham.—The late Local Board applied to the Local Government Board to borrow £7,000 for buying the works of the local electric light company. Their successors—the District Council—however, are moving in an opposite direction.

Babcock and Wilcox, Limited.—The Board have declared interim dividends at the rate of 6 per cent. per annum on the preference shares and at the rate of 10 per cent. per annum on the ordinary shares for the six months ended December 31.

Portsmouth.—The Electric Light Committee of the Town Council have ordered a hundred electricity meters, and mains will be extended to Arundel-street, Marmion-road, Castle-road, Lake-road, St. Mary's-road, and the infectious diseases hospital.

Bootle.—The Town Council have decided that the sum of £4,300, sanctioned by the Local Government Board for alterations to the Town Hall and other municipal buildings, and for lighting the same by electricity, be borrowed from the Yorkshire Penny Bank, of Leeds.

Consolidated Telephone Company.—The Consolidated Telephone Construction and Maintenance Company, Limited, state that it has been arranged to cancel the heads of agreement between that Company and the Pneumatic Typewriter Company respecting the manufacture of typewriters.

Frizington.—A meeting has been held of the Arlecdon and Frizington Urban District Council at which Mr. Richards gave notice of motion to consider the question of lighting the district with electricity. He asked the clerk to prepare for next meeting an estimate of what their present light had cost them for the last three years.

Llanelly.—The construction of large municipal buildings has induced the local authority to consider the question of lighting the new Town Hall, the Athenæum buildings, the new Market Hall, the market premises, and the chief streets of the town by means of electricity, and the borough surveyor has been instructed to report to the Board.

Carbon Rods and Battery Plates.—Messrs. Krupka and Jacoby inform us that they have transferred their business to 15, Queen-street, Cheapside, E.C., where they keep in stock carbon rods, battery plates, agglomerate blocks, and dry batteries, manufactured by Dr. Alb. Lessing, of Nürnberg, contractor to the German Imperial Government.

Kendal.—The Town Council have taken into consideration a minute of the Electric Lighting Committee, recommending the Corporation to give notice of objection to the granting of a provisional order to the Windermere and District Electricity Supply Company. Councillor Jefferys moved the adoption of the recommendation of the committee, and this was agreed to.

Ottoman Railways and Public Works Corporation, Limited.—This Company has been registered with a capital of £550,000 to acquire conventions, firmans, concessions, rights, or privileges for the construction of railways, tramways, or other public works, granted, or to be granted, by the Sultan of Turkey, or the Sublime Porte, or any other sovereign State, Government, or any other authority.

Appointment Vacant.—The Southampton Electric Light and Power Company require a man accustomed to bare copper mains and low-pressure three-wire system to act as outside foreman on mains, house services, etc. The wages are 30s, and uniform. Applications, giving testimonials and stating past experience and age, are to be sent to the engineer, Back of the Walls, Southampton.

Sheffield.—A local paper states that on Wednesday evening the users of the electric supply from the works of the electric light and power company experienced the annoyance of the stoppage of the supply. The explanation of the company is practically that the mishap is due to their desire to supply the full demands of their customers, and that in the attempt the old machinery has been overtaxed. They ask for the forbearance of the public until the new plant is ready.

Oswestry.—Complaints are being made in the Council with respect to the quality and price of the gas. Councillor Williams said that he would suggest that the Council communicate with the Oswestry Electric Lighting Company with a view, if it were thought advisable, of taking over their concern. Councillor W. T. Jones said that he understood the company was practically dead. Councillor Ellis remarked that it had never lived, and consequently could not be dead.

Dover.—It has been stated at a meeting of the Town Council that the bill for the work carried out by the Council in connection with the laying of the electric mains amounted to £138. 1s. for December. £1,322. 13s. 9d. has been so far spent on labour and materials in the portion of the work done by the Council's men, for which the Corporation will be repaid. The use of the steam-roller was granted to Mr. H. Stiff on the usual terms to make a roadway round the electric light works.

Bath.—Mr. Gatehouse, the electric light inspector to the Town Council, reported to the latter last week that there had been 34 failures during the fortnight. He stated that nearly the whole of the 34 lamps were extinguished on account of the bad quality of the carbons. These contained siliceous matter which during combustion fused into a species of glass, thereby stopping the working. It was agreed that a representation be made to the electric lighting company.

Battersea.—In view of the applications which are being made by private companies for permission to lay down mains in the district for supplying the electric light, the Battersea Vestry have resolved to enter formal notice of opposition, and have also appointed a special committee to consider and report as to the advisability of the local authorities undertaking the supply on their own account. The committee which was appointed at the last meeting of the Vestry consists of 13 Progressives and seven Moderates.

Grasmere.—Correspondence has been read at a meeting of the Urban District Council from the electric light company and Mr. Gatey, and some discussion arose as to opposing their application to the Board of Trade for a provisional order. Mr. Armstrong said the proper course to take was to suggest a joint committee to act with the neighbouring Boards. The question would then be thrashed out, and time would be saved. It was agreed that the chairman and vice-chairman be appointed to meet members of the other Boards and consult on the question.

City and South London Railway.—The receipts of the Company for the week ended January 13 were £1,001, against £951 for the corresponding week of 1894, or an increase of £50. The total receipts for the current period of the present half-year are £2,005, against £1,941 in the corresponding period of 1894, an increase of £64. For the half-year just ended the Board announces a dividend on the ordinary stock at the rate of 1¼ per cent. per annum, £950 being carried over. The dividend for the corresponding period was at the rate of ¾ per cent. per annum, when £1,063 was carried over.

Crompton and Co., Limited.—This Company have this week invited subscriptions for £100,000 5 per cent. first mortgage debentures at par. The business has been carried on as manufacturers of electrical plant by a limited company since 1888, and the average net profits for the past six years, it is stated, have been £10,320 per annum. The debentures will be repayable at par on January 1, 1920, but the Company reserves the option of repaying any portion of the bonds by April, 1900, at 5 per cent. premium, or earlier by purchase in the market, or at six months' notice at the price of £110 per cent.

Chard.—Councillor E. Gawler suggested at a recent meeting of the Town Council the desirability of the Council acquiring the Chard reservoir—a sheet of water about 70 acres, formerly used for supplying the canal between Chard or Bridgwater—as a recreation place for the town. He thought the reservoir and the surrounding land might be made a favourite pleasure resort, and the water might be utilised as power for lighting the town with electric light. The idea was favourably entertained, but was deemed impracticable at the present time in view of the many other matters pressing for the attention of the Council.

St. Helens.—A monthly meeting of the St. Helens Corporation Water Committee has been held, when the Baths Sub-Committee recommended certain repairs to the baths in Warrington Old-road. Alderman J. C. Gamble remarked that several members of the Gas and Lighting Committee had inspected the baths, and they thought that the building would be very suitable for the generation of electric light when the Corporation completed their arrangements for its supply within the borough. It was decided that the Baths Sub-Committee and the Gas Sub-Committee should jointly consider the matter and present a report at a future meeting.

Ealing.—A letter has been read at a meeting of the Urban District Council from a Mr. Baker making a claim upon the Council in respect of an alleged infringement of a patent held by him of an apparatus used in connection with the machinery laid down for the electric light. The surveyor advised that the claim could not be sustained, and the Council resolved that they could not entertain it, though they formally referred the letter to Messrs. Bramwell and Harris, the consulting engineers employed under the electric lighting scheme. The new Electric Lighting Committee consists of the following members: Messrs. Box, Hedges, Baker, Hays, Kasner, and Thayers.

Ventilation of Manholes.—Messrs. Peirson and Co., of 124, Fenchurch-street, E.C., have drawn our attention to their "Simplex" ventilating system for electric light manholes, sewers, coal and other cellars, and all underground work where it is connected with roads. The system consists in the use of tubes, the position in which the ventilating tubes are fixed relatively to the cableways, gas or sewer pipes, etc., bringing about, it is claimed, a complete circulation of air in the manhole, and consequently preventing the dangerous accumulation of gas therein. The ventilator pipes are strongly made in cast iron, and with the readiest means of cleansing and repairs.

Folkestone.—The Town Council have held a meeting at which a letter was read from Mr. W. G. F. Webster offering to enter into an engagement to light the Leas with electric light for a term of years, at the end of which time the Corporation would be able to purchase the plant, etc., if they thought fit. He said his present plant was ample for the purpose, and he referred the Corporation to the installations he had already put in. The Corporation could, if they pleased, have their own cables and wires. The letter was referred to the Lighting Committee to consider. The names of Councillors James and Peden have been added to the last appointed Electric Light Committee.

Telephony at Leeds.—The National Telephone Company asked leave some months ago from the Leeds Highways Committee to lay a number of wires under the pavements of the city instead of overhead. The committee decided to comply with the request if the company would undertake to pay an "acknowledgment" of 5s. in respect of every subscriber who might use the wires. The company, however, protested against this impost, and pleaded that the postal authorities paid nothing, or only a nominal sum for the right to lay telegraph wires underground. The committee, however, declined to give way, and there the negotiations seem to have ended, for all additional wires are being erected in the air.

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Industrial Inventions Development Company, Limited.—This Company has been registered, with a capital of £50,000 in £1 shares, to enter into and carry into effect an agreement, which has already been prepared, and is expressed to be made between this Company and F. L. Lawson for the purchase of an interest in certain inventions therein mentioned; to apply for, purchase, or otherwise acquire, use, exercise, develop, grant licenses in respect of, or otherwise turn to account any patents, *brevets d'invention*, licenses, etc., and to carry on business as bankers, capitalists, financiers, concessionaires, merchants, etc.

Richmond.—The Finance Committee of the Town Council have reported that the electric lighting company have now deposited £50 in accordance with the resolution of the Council, and that there was also £67 still remaining deposited in accordance with the contract. The clerk to the Richmond Main Sewerage Board has read a letter from the Board's contractors for the electric light installation, Messrs. Drake and Gorham, suggesting a periodical inspection of the Board's electric lighting installation. The cost would be £3. 3s. a year and travelling expenses. The Engineer, in reply to a question, said that if the Board tested the installation themselves the first cost of the apparatus would be very heavy. It was resolved to accept the offer if the contractors would accept £4. 4s. a year inclusive.

Anglo-American Telegraph Company, Limited.—At a meeting of the board of directors, held on Friday last, it was resolved, after placing the sum of £12,000 to the credit of the renewal fund, to recommend to the proprietors the declaration of the following dividends: (1) a balance dividend of 14s. per cent. upon the ordinary consolidated stock; (2) a balance dividend of £1. 8s. per cent. upon the preferred stock, both payable on January 26 next, less income tax. After paying the dividends, there will be a balance of about £485 to be carried forward to the next account. The dividends, together with those already paid, will amount to £2. 2s. per cent. on the ordinary consolidated stock and £4. 4s. per cent. on the preferred stock for the year 1894. The register of transfers will be closed till January 25.

Walsall.—In connection with the tenders sent in for the central electric light station, to which reference is made in another column under "Results of Tenders," the town clerk has read correspondence which had passed between the Electric Construction Company and himself upon a complaint by the former that they had been unfairly passed over, and had not had an opportunity of sending in an amended tender. Since the Council assembled, a communication had been received from the chairman of the Electric Construction Company, addressed to the Mayor, stating that the company were largely influenced in the negotiations for the restarting of the electric trams by the understanding that the Corporation were favourably considering the company's tender for the electric works. The Town Clerk and the Mayor denied that there was any such understanding.

Newington, S.E.—The Clerk to the Vestry stated that he had received notice from the County of London and Brush Provincial Electric Lighting Company, Limited, of their intention to apply to the Board of Trade for a provisional order to authorise and empower the company to produce and supply electricity within the area of the parish. He asked for instructions, having regard to the resolution adopted by the Vestry on November 16, 1892, opposing the granting of the order to the company. Mr. Smithers said none of them would care to see a company come to Newington and obtain the provisional order, and the Vestry would do well to prevent another monopolist arising in their midst. He thought they ought soon to have their parish better lighted—it would mean a lower police rate. He moved that the company's application be opposed by the Vestry. Mr. Hammond seconded, and the motion was carried.

Taunton.—The Town Council have adopted the following report, which was submitted by the Electric Lighting Committee: "Your committee report that the Local Government Board has sanctioned the borrowing of £5,000 for purposes of electric lighting, to be repaid in 25 years from the date of borrowing—the works in connection with the No. 2 sub-station will be proceeded with at once. Your committee report that the arrangement with Mr. Newton as to the testing and subsequent purchase of his transformers has fallen through, and they ask the Council to authorise them to obtain the transformers required for the No. 2 sub-station elsewhere. Your committee recommend that the collector collect the accounts connected with the electric lighting undertaking at a fixed sum of £15 a year, and that the borough accountant keep the accounts in connection therewith at an extra salary of £15 a year."

Chelsea.—The Chelsea Electricity Supply Company have submitted a tender to the Chelsea Vestry for lighting some of the streets of the parish with electricity. The cost to the Vestry of the lamps to be lighted during ordinary lighting hours would be £28 per lamp per annum, with a minimum of 50 lamps, the contract for lighting to be not less than seven years in duration. The lamps and lamp-posts cost from £25 to £30 each, and will be provided by the Vestry, the cost of the mains and cables necessary for conveying the supply of electricity to the lamps being borne by the company. The price of £28 will include the maintenance of the lamps in working order. The painting and glazing of the lamp-post and lantern will be done by the Vestry. The cost of gas over the area proposed to be treated is £574, while the cost of electricity on these conditions will be £1,400. The matter will be considered at the next meeting.

Dublin.—Dealing with matters municipal at a meeting of the Dublin Corporation, at which Alderman Dillon was re-elected Lord Mayor for 1895, the Mayor stated that in their paving work they had carried out the usual amount of work. In this connection they would have before them an application from the tramway company of a most interesting character. They were seeking powers to run the tramcars over the streets by means of electricity, and he trusted the Council would view this matter with favour so that such an improved means of locomotion would be secured for the city. Another important question was that of the lighting of the city. The electric lighting had proved eminently successful during the year. Last year they had 140 customers; now they had 196. They now had 16,600 lamps. Consumers had ordered many more, and their plant was now almost completed, so that they would be able to meet the demand.

Windermere.—The chairman of the District Council, on behalf of the committee appointed to consider the draft electric lighting order, reported that the committee had discussed the matter in conjunction with committees from Ambleside and Bowness. A document named "the Ulverston agreement" was placed before them, with which they did not thoroughly agree. In the end it was unanimously resolved, so far as Bowness and Windermere were concerned, to agree to the provisional order, as they considered that in it the interests of the public were sufficiently safe guarded. Mr. Fell said he had seen the engineer of the scheme that day, who had told him that whatever arrangement was the best arrangement with any of the different authorities would also apply to the whole of them; so that if any portion of the district was able to get any better terms, those terms would apply to Windemere. The report of the committee was adopted.

Dundee.—A report by Mr. George Baxter, the water engineer, was submitted on Tuesday to the Water Committee of the Town Council upon the available supply of water from the gathering grounds, the present capacity of the works, and other matters bearing on the question of increased consumption of water for trade and other purposes. With regard to the utilisation of surplus water, Mr. Baxter says: "The power required at the electric lighting station is fully 700 h.p., and the power that might be obtained by the fall of our water into Stobsmuir would not exceed 9 h.p. I may point out that the question of water power for the electric lighting of the city was fully considered by the previous convener when the scheme was in hand, and so far as the public water supply was concerned, it did not require very serious consideration to arrive at the opinion that no help could be derived from it."

Bowness.—A meeting of the Urban Council has been held, at which the Chairman said the Lighting Committee had met the solicitor of the electric lighting company at Rigg's Hotel, and after examining the agreement which the company had made with the Ulverston district, the committee unanimously agreed that the Council offer no opposition to the company's obtaining the provisional order. The maximum price chargeable by the company was set at 8d. per unit, which, the committee were told, was equivalent to 4s. per thousand feet of gas. Mr. Bownass said the committee went into the matter very carefully as regarded the question of giving consent, and it appeared that in the provisional order the interests of the public were very carefully protected throughout. The only point of importance in the order was the purchase clause, giving local authorities power to purchase within 42 years on a 5 per cent. basis. The Council agreed to consent to the provisional order.

Cheltenham.—A letter has been read at a meeting of the Town Council from Messrs. Griffiths, Ryland, and Co., on behalf of Mr. Reed Muller, of Staverton. It alleged that a horse belonging to Mr. Muller had fallen into an excavation made in the roadway in Lower High-street by the Corporation men for purposes alleged to be connected with the electric light, and sustained bad injuries to his knees. Ten pounds compensation was claimed. A claim was also made by Mr. J. R. Higgins for 15s. damage to boxes, etc., at 108, High-street, owing to a service pipe being cut by one of the workmen employed in the trench. Mr. Lionel Millns, 20, All Saints'-road, claimed damages through falling into an exposed excavation near the end of North-street, and injuring his thumb and ruining a pair of dress trousers in the tar in the trench. It was resolved to offer Mr. Muller £5 without prejudice, to pay Mr. Higgins the amount of his claim, but to admit no liability in the case of Mr. Millns's accident.

Liverpool.—A most important decision was arrived at on Monday by the Lighting Committee of the Corporation, over which Alderman F. Smith presided. In view of the action of the City Council last week empowering the committee to enter into negotiations for the purchase of the Liverpool Electric Supply Company's undertaking within the city, various matters appertaining to the lighting of the city were under discussion, but a new departure in the consideration of the question was initiated by a proposal that the Corporation should make application to the Board of Trade for a license to enable them to light the streets of the city by electric light, and, if need be, to supply electricity in the same way as now being done by the Liverpool Electric Supply Company. This proposition gave rise to an animated debate, and it was only adopted by four votes to three, the division being—for: Alderman F. Smith, Alderman Hawley, Councillor Brownbill, and Councillor Topp; against: Councillor W. J. Burgess, Councillor Austin Taylor, and Councillor Petrie.

City of London Company's Revenue.—Mr. J. Cecil Bull, manager and secretary of the City of London Electric Lighting Company, Limited, has sent us some figures concerning the Company's revenue during the quarter ended December 31, 1894. The receipts from the sale of current for public lighting in that period were £3,181. 3s. 2d., as compared with £3,105. 4s. 9d. in the corresponding quarter of 1893; and from private lighting

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£26,052. 5s. 3d., as against £13,091. 9s. 11d. in the same quarter of 1893. The estimated revenue from other sources is £404, as compared with £450. It will be seen that the total increase during the last three months of 1894 shows an increase over the corresponding quarter of 1893 of £12 990 13s. 9d. Another interesting item is that the equivalent of 135,460 8-c.p. lamps were connected to the mains on December 26, 1894, being an increase of 21,429 during the quarter; whilst the number of lamps connected on December 26, 1893, was 65,341, the increase in that quarter being 11,896.

Ventilating and Warming Appliances.—A new catalogue is being issued by Messrs. Baird, Thompson, and Co., Limited, of Charlton Engineering Works, Islington, of ventilating, warming, drying, and other appliances of which they make a speciality. This new edition contains a large number of new and artistic designs suitable for all classes and styles of architecture. The company are now enabled to turn out their appliances more expeditiously and at a greater saving of cost, in consequence of which reduction has been made in prices. The following are some specialities: ventilators (automatic and mechanical), extractors, and inlets; electric ventilators for all purposes, air propellers, belt driven or with high-speed engine; water motor, compressed-air motor, also by electricity; compressed-air system of ventilation, warming, and drying, also cooling, water-spray system of ventilating and cooling, smoke flue ventilators, chimney cowls, systems of heating by steam, hot water, and hot air, and the Plenum system of combined ventilating and warming for all classes of buildings.

Birmingham Central Tramways Company.—The petition of this Company for authority to reduce capital has come before Mr. Justice Stirling. Counsel stated that the Company was formed in 1881. Its paid-up share capital was £488,000—£388,000 in ordinary £10 shares and £100,000 in 5 per cent. preference shares. Its difficulties had arisen in consequence of taking over concessions and leases of other tramways outside the borough. These had proved unremunerative, and had been abandoned; but the amount of capital lost or unrepresented by available assets was now set down at £194,000, or half the ordinary capital paid up. This the Company proposed to strike off by reducing the value of the ordinary shares from £10 to £5. There were debentures to the amount of £162,000, and in Chambers the judge had not required that notice should be given to them. Mr. Justice Stirling said he would require the Company to advertise the reduction, and to give notice to the Birmingham Corporation and some other of the debenture-holders. If, within a week after such notice, no objections were raised, the order asked for would be made.

Southport.—A meeting of the Electricity Committee of the Town Council was held on December 18, when they resolved that a low-tension cable be laid down in Portland-street from Coronation-walk corner to Nelson-street; also that an order be given for 10 10-ampere meters. It was resolved that the Watch and Public Halls Committee be informed that the failure of the lights in the Council chamber recently was owing to insufficient fuses on the consumers' side of the meter, for which the Electricity Committee were in no way responsible. At a meeting of the Town Council, Councillor Hesford proposed and Councillor Todd seconded the adoption of the minutes. The Mayor, referring to the erection of the new chimney, said he hoped the greatest care would be taken in carrying out that work, and that the best materials would be used throughout. Councillor Hesford stated that they had specified that the chimney should be sufficient for the requirements of 10 boilers working at the same time, that it should withstand a wind pressure of 90lb. to the square foot, and that the foundations should be to the satisfaction of the committee. The motion was carried.

Dewsbury.—The minutes of the Lighting and Water Committee of the Town Council, dated December 17, stated that a letter received from Messrs. Crompton and Co. suggested that the Corporation should have a supply of carbons for use in the new arc lamps. The town clerk reported that, after seeing the chairman and the electrician, he had given Messrs. Crompton and Co. an order for the supply of the 650 pairs of carbon, and his action was ratified. The resolution referring to workmen required at the electric lighting station was reconsidered. The electrician laid before the committee a report upon the duties of the several workmen engaged, and recommended that at present at least not one member of the staff could safely be dispensed with. It was resolved that, after reconsideration of the matter, the committee do still adhere to their resolution of November 19. Alderman Robinson, in moving the confirmation of the minutes at a meeting of the Town Council, said that every member of the committee was present when the matter was referred back to the committee for reconsideration relating to the men employed at the electric lighting station. The electrical engineer was present, and he could not at present see his way to curtail the staff previously recommended, but gave the committee an assurance that if it was necessary to diminish the staff as time proceeded he would do so. Councillor Archer seconded the motion, and it was carried.

Cardiff.—On Monday, at a meeting of the Borough Council, Councillor Good moved, "That this Council herewith resolves that a special committee be appointed to make a searching and impartial investigation into the cause or causes of the late extraordinary and vexatious delay in completing the electric lighting of the town, and as contrary to the statement made both by the electrical engineer and the borough surveyor, according to the minutes of September 19, 1893, that the said lighting should be carried into effect either in December, 1893, or January, 1894." Councillor Morgan Morgan seconded the motion, as he explained, so as to put the matter in order. Councillor Beavan denounced the motion as a reflection upon the Lighting Committee. The Mayor, as a member of the Lighting Committee, asked the Council if they supposed for a moment that the members of the Lighting Committee would continue to act if the resolution was passed? For his own part, as chairman of the Lighting Committee, he would not think for a moment of acting any further on the committee if the resolution was passed. Why didn't they ask for information? Councillor Jenkins asked if the borough engineer could inform the Council whether they had had to pay for the lighting experiments made at the station in the shape of wages to the men employed there, and with regard to the consumption of coal. The Mayor said that the men employed at the station were employed there permanently. Latterly, experiments had been made during the period in which the street lamps had been lighted, besides which they had 39 private customers. They had afforded light to these customers and had used their coal for this purpose, and for this they were paid. Applications for the light were coming in fairly well now. He was pleased to see from the returns at Portsmouth that they in Cardiff were in exactly the same position with regard to plant, rectifiers etc. At Portsmouth they had only had the light going six months, and expected to declare a dividend of 5 per cent. He admitted that there had been considerable delay in getting the electric light in operation in Cardiff, but pointed out that they had been 18 months looking for a site, and they were afterwards delayed, owing to a strike, in getting their machinery. The motion was then put to the meeting and lost by a large majority.

Electric Construction Company, Limited.—This Company, who report that the past year has been a very busy one with them, state that the reconstruction of the Company took place during the latter part of 1893, that during 1894 the staff of the Company and the business generally have been completely reorganised, and that Mr. Parker left the Company in April last, and Mr. Blackburn was appointed chief engineer. Since then the re-establishment of the business has proceeded satisfactorily. Mr. Garcke retired from the position of managing director at the end of the year. During the period of his connection with the Company the reconstruction and reorganisation above referred to have been carried out, and the Company is now in smooth waters. The business of the Company has steadily increased, and we are informed that the orders executed during the past half-year have been of an amount equal, if not greater, to that of any previous half-year in the Company's history. The central-station work on hand during the year has included complete electrical equipments for the Wolverhampton Corporation and for the united parish of St. James and St. John, Clerkenwell; dynamos and accessories for the lighting stations of Halifax, Crystal Palace District, Chelsea, Liverpool, Stafford, Aberdeen, Nottingham, etc.; and a large number of motor generators, both continuous current and alternating current, for various stations, including Brighton Corporation, Oxford, etc. Traction work has included the extensions of the Liverpool Overhead Railway, complete electrical equipment of the Madras electric tramways, and electric locomotives for South Africa. In general dynamo, motor, and switch work the Company has been exceedingly busy, an unprecedented number of machines for private firms having been delivered during the autumn. Several large orders for power transmission, mining, and pumping plant have also been executed. The orders at present in hand are sufficient to keep the shops fully employed for several months, and include the equipment for Clerkenwell, alternators and transformers for the St. Pancras Vestry, six 65-kilowatt transformers for Birmingham, plant for South Africa, dynamos for the War Office, motor transformers for Manchester and Birmingham, lighting plant for China, etc., in addition to a large number of general orders.

Halifax.—On Thursday night last week, in celebration of the completion of the Corporation electric light works, the contractors, the workmen who have been employed on the undertaking, and others had dinner together at the Talbot Assembly-room. The company numbered about 170. Alderman J. Brook, as chairman of the Gas and Electric Light Committee of the Town Council, presided, and the other members of the committee present were the Mayor (Alderman M. Booth), Alderman Patchett, Alderman Brear, Councillors T. Greenwood, R. Hodgson, W. H. Spencer, D. Woodhead, Rushworth, and T. Braithwaite. The gathering also included the architect (Mr. W. H. D. Horsfall), Mr. T. P. Wilmshurst (electrical engineer), and Mr Holgate (gasworks manager). Councillor T. Greenwood proposed "Success to the Electricity Works." He remarked, in doing so, that he considered they had an installation that was second to none in the world. It was in 1892 that the then Mayor, the late Alderman Davis, brought the question of the electric light forward, and the matter came before the Town Council as to whether they should carry out the necessary works themselves, or allow the undertaking to be transferred to a private company. The result was that they decided that the works should be municipalised. The cost of the installation at Halifax was about £6 per light. The Corporation had now applications for 3,000 16-c.p. lamps. Their full capacity was 6,000 lamps, and he felt confident that before three years were over this would be utilised to its fullest capacity. The chairman reminded the meeting that the sanction to proceed with the works was only received by the Corporation in December, 1893. That they should have had the works brought to their present position in so short a time was, he thought, exceedingly creditable to all concerned. Regarding the income, they were deriving from the present number of lights an income of fully £2,000 a year. It was not, of course, to be expected that the works would pay immediately. They had now only running capacity of 500 h.p., and they had sufficient

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room, both for boilers and engines, that would give them three times that capacity, without any extension of buildings being necessary. Mr. Wilmshurst said that they had the satisfaction of knowing that they had the very best system they could possibly have. They were doing nothing experimental, but they were doing what had been done in electric light works before, where the methods they were adopting had answered successfully. Throughout they had had nothing but first-class material and first-class work, and he considered that the different contractors deserved their thanks for the heart, soul, and energy they had put into the work. No one entering the engine-room could help being struck with the solid and substantial look of the plant. In fact, it looked as if it had come to stay, and he must say that Messrs. Pollit and Wigzell, of Sowerby Bridge, deserved very great praise for the creditable show they had made in their engines.

PROVISIONAL PATENTS, 1895.

JANUARY 7.

378. **An improvement in dynamos or electric generaters by means of which a constant pressure is maintained under varying speeds.** George Edwin Fletcher, "The Homestead," Cale Green, Stockport.

396. **An improved grid for secondary battery plates.** Alfred Slatter, 7, Ridgmount-street, Bedford-square, London.

398. **Improvements in automatic telegraph instruments.** Henry Whawell, 11, Aldebert-terrace, Albert-square, Clapham, London.

432. **Improvements in electric accumulators or secondary batteries.** Eugene Ageron and Alfred Fournier, 18, Buckingham-street, Strand, London.

437. **Improvements in and connected with electric arc lamps.** John Brunswick Barton, Norfolk House, Norfolk-street, London. (William Jandus, United States.)

JANUARY 8.

480. **Improvements in electrical measuring instruments.** Edward Stanley Shoults and Gustav Binswanger, 73, St. Stephen's-road, Upton Park, London.

497. **Improvements in and relating to electric railways.** John Charles Love, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

523. **An improvement in lightning arresters.** Reginald Belfield, 28, Southampton-buildings, Chancery-lane, London. (The Westinghouse Electric and Manufacturing Company, United States.)

525. **Improvements in magnetic cut-outs.** Leonard Andrews, 166, Fleet-street, London.

527. **An improved galvanometer lamp, stand, and scale.** Henry Frederic William Burstall and James Joseph Hicks, 23, Southampton-buildings, Chancery-lane, London.

JANUARY 9.

530. **An improved electrical current reverser and testing key.** Richard Harvey Tonking, 84, Annandale-road, East Greenwich, London.

531. **Dynamo machines for producing alternating electric currents of low tension.** Arthur George Adams, 29, Storer-road, Loughborough.

541. **An improved combined electric bell and indicator.** August Eckstein and Richard Pentney Eidsforth, 45, Chapel-street, Salford, Manchester.

545. **Improvements in electrical switches.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford, Manchester. (Complete specification.)

546. **Ignition and gas-generating body for explosive engines rendered incandescent by an electric current.** Anton Niemczik, 10, Friedrichstrasse, Berlin. (Complete specification.)

JANUARY 10.

619. **A mode of giving warning by means of electric bells of the approach of trains at level crossings on railways.** Thomas Ireland, Babworth-road, Retford, Notts.

620. **Improvements in electrical apparatus for protection against fire** William Jeffrey and Frank Taylor, 11, Queen Victoria-street, London.

632. **Improvements in galvanic or primary electric generaters.** Eugène Ageron and Alfred Fournier, 18, Buckingham-street, Strand, London.

656. **An automatic clutch-sustaining device for brackets, pedestals, or other fixed or movable supports for electric light lamp and other purposes.** John Edward Preston, 58, Lombard-street, London.

671. **Improvements in magnetic cut-outs.** Leonard Andrews, 166, Fleet-street, London.

JANUARY 11.

684. **An improvement in and relating to lamp-holders for incandescent electric lamps.** George Christopher Cannon, Engineering Works, Bellshill, Lanarkshire.

687. **An improvement in machines for transforming continuous or direct currents of electricity and for other purposes.** George Cheffey-James and Harry Percy Ward, 25, Thoresby-road, Hillsbro', Sheffield.

712. **Process for the electrolytic extraction of nickel and cobalt from ferruginous raw materials.** Ludwig Münzing, 433, Strand, London.

736. **Electric alarm detector and valve for chlorine gas.** Richard William Hill, 97, Newgate-street, London.

737. **Production of aluminium and generator of electricity.** Richard William Hill, 97, Newgate-street, London.

JANUARY 12.

807. **A process for the electrolytic decomposition of alkaline chlorides.** Wilhelm Siepermann and Hermann Riegermann, 4, South-street, Finsbury, London.

816. **Production of gaseous ammonia by electricity.** Richard William Hill, 97, Newgate-street. London.

817. **Production of nitric acid by electricity.** Richard William Hill, 97, Newgate-street, London.

818 **Improvements in phonographs.** Vincenz Lahola and Adol Sachs, 23, Southampton-buildings, Chancery-lane, London.

825. **Improvements in arc electric lamps.** John James Mann and Lucien Hermand, 47, Lincoln's-inn-fields, London.

831. **Improvements in and relating to electric arc lamps.** Robert Cornelius Quin and Benjamin Symmons, 124, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1888.

11898. **Indicating strength of an electric current.** Shallenberger. (Second edition.)

1891.

4583. **Electric supply meters.** Perry. (Second edition.)

1894.

3476. **Electric bells.** Little.

3667. **Telegraphic apparatus.** Phonophore Company and Smith.

4691. **Connecting and disconnecting electrical circuits.** Lundberg and others.

7121. **Electric lighting apparatus for railway cars, etc.** Biddle and Kennedy.

22192. **Electric exploder.** Siemens Bros. and Co. and Schloemer.

22453. **Insulated electric conductors.** Robinson.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Bournemouth Electric Company	—	—
Brush Company, Ordinary	2	2⅜-2½
—— Nom. Cum., 6 per cent. Pref.	2	2⅜-2½
—— 4½ Debenture Stock	100	111-114
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	15-15½
—— 5 per cent. Debenture Stock	115	130-133
City and South London Railway, Consolidated Ordinary	100	44-46
—— 4 per cent. Debenture Stock	100	125-127
—— 5 per cent. Pref. Shares	10	13⅜-14½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	3-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	97-102
Electric Construction, Limited	2	½-⅝
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1½-1⅝
Elmore's French Company	2	1/16-5/16
Elmore's Wire Company	2	⅜-1⅛
Fowler-Waring Cables	5	½-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	9-10
—— Preference	—	12
House-to-House Company, Ordinary	5	2½-2⅝
—— 7 per cent. Preference	5	6½-7
India Rubber and Gutta Percha Works	10	25½-26⅛
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	—	7-7½
Liverpool Electric Supply, Ordinary	5	6 15/16-7 1/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8¾-9
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	½-⅝
Metropolitan Electric Supply	10	9⅜-10⅛
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	5½-5⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-6⅛
—— 3½ per cent. Deb. Stock	100	103-105
Notting Hill Company	10	7-7½
Oriental and Electric Company, £1 shares	1	1⅛
—— £5 Shares	—	7-7½
—— £4½ shares	—	5⅜-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8½
—— 7 per cent. Pref.	5	8⅜-9⅛
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7½-7⅝
Yorkshire House-to-House	4½	4½-4⅝

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NOTES.

Calendar.—A calendar for 1895 has reached us from Mr. J. H. Sankey, of Iron Bridge and Essex Wharves, Canning Town, E.

Electric Drills.—An electric drill has been employed in the drilling of the bottom plates of the "Talbot" at Devonport Dockyard.

Physical Society.—The date given in our last issue of the meeting of this society should have been January 11, 1895, and not November 11, 1894.

Telephony.—On Wednesday Llanwrda, Pumpsaint, and Melin Rhos (Farmers) were connected by telephone to the Post-Office system of telegraphs.

Electric Lighting at Buluwayo.—It is stated that arrangements have been made for a telephone exchange and the installation of electric light at Buluwayo.

Australian Telegraphy.—Telegraphic communication with the Antipodes has been suspended for some days owing to damage to the land lines on the other side.

Strike.—A strike of electric tramway employés is taking place at Brooklyn, New York. A full report of the proceedings will doubtless be found in our contemporaries.

Glasgow Tramways.—The Tramway Committee of the Town Council have declined a proposal submitted by a private firm offering to work several of the lines by electricity.

Finsbury Park and City Railway.—The Examiner on Standing Orders passed on Wednesday the Bill for constructing an electric railway from Finsbury Park to Moorgate-street.

Lecture.—Mr. W. Perren Maycock, M.I.E.E., gave on Saturday evening last a lecture on "Electricity" at the Thornton Heath Polytechnic, Croydon. The lecture was illustrated by experiments.

Electro-Harmonic Society.—As mentioned in our last issue, a smoking concert of this society will be held this (Friday) evening at the St. James's Hall Restaurant. The programme was given a week ago.

Explosion.—An explosion occurred on Friday afternoon at the bottom of St. James's-street, S.W. It was accompanied by a report, and the iron lid of a manhole was blown in the air and fell on the footpath.

Proposed Teaching University.—Lord Rosebery received on Tuesday deputations for and against the proposed teaching university for London. He expressed himself in favour of the report of the Gresham Commission.

Telegraphy in the East.—Preliminary work has been commenced in connection with the extension of the telegraph lines from Burmah to China. A telegraph line connecting Darya Khan with Dera Ismail Khan is to be constructed.

Telegraphy in Madagascar.—The Hovas, a *Times* correspondent says, are constructing a telegraph line to Vatomandry, in order to secure the direct transmission of their telegrams to London without the risk of their being intercepted by the French.

Research.—The Executive Committee of the City and Guilds of London Institute have awarded the first Salters' Company's Research Fellowship for the encouragement of higher research in chemistry, in its relation to manufactures, to Mr. Martin O. Foster, Ph.D., F.C.S.

Acton Tramways.—A public meeting has been held in regard to the proposed tramway extension to Acton-hill. An address was delivered by Mr. J. Clifton Robinson, the managing director of the United Tramways Company, who made special reference to the point of electric traction.

City and South London Railway.—The Examiners on Standing Orders of the House of Commons on Monday passed the City and South London Railway Bill to extend the time for the completion of the underground electric railway authorised in 1890 and to raise £30,000 additional capital.

Light Railways.—The Committee on Light Railways appointed at the Board of Trade conference on the 6th of last month held their final meeting on Wednesday, Sir Bernhard Samuelson being in the chair, when the report to be made to the conference at its next meeting on the 31st inst. was finally agreed upon.

Society of Arts.—The third Cantor lecture on "The Arc Light," by Prof. Silvanus P. Thompson, D.Sc., F.R.S., will be delivered on Monday. It will deal with arc lamp mechanism, the requirements to be met and methods of fulfilling them, alternate-current lamps, special lamps, qualities of carbons, and accessories.

Personal.—The Electrical Company, Limited, of Charing Cross-road, inform us that they have obtained the services of Mr. J. Stottner, one of the engineers from the Allgemeine Elektricitäts-Gesellschaft, of Berlin, who represented this influential firm at the Chicago Exhibition. The Electrical Company anticipate doing a large business in the transmission of power department, which is being managed by this gentleman.

Institution of Junior Engineers.—The tenth anniversary of the Institution of Junior Engineers, now numbering 400 members, is to be celebrated by a dinner the Westminster Palace Hotel on Saturday. The chair will be taken by the president, Mr. A. Siemens, who will be supported by Major-General Webber, C.B., Sir A. K. Rollit, M.P., and Profs. W. E. Ayrton, J. A. Ewing, George Forbes, and John Perry, F.F.R.S.

Chloride Storage Batteries.—The Chloride Electrical Storage Syndicate, Limited, inform us that the recent litigation or disputes between themselves and the Electrical Power Storage Company, Limited, and the Electric Construction Company, Limited, have been settled on mutually satisfactory terms, and that they continue to make and sell their batteries as hitherto. We are glad to publish this item. No doubt the consolidation of storage battery interests in the United States, to which we referred a few week ago, has had something to do with bringing about this satisfactory result.

Wear of Trolley Wires.—A statement was recently made in the *Elektrotechnische Zeitschrift* to the effect that a particularly strong wear of the trolley wires in the case of electric tramways took place through electrolysis in damp weather if those conductors formed the positive wires of the system. Herr von Hefner-Alteneck now writes to that journal expressing the opinion that the wear of the trolley conductor must not be attributed to electrolysis due to moisture, but rather to sparking caused by bad contact between the trolley wheel and the trolley wire, or between the sliding collector and the conductor.

Water Power in the United States.—A plan for utilising the water power of the Susquehanna River as a means of generating electric power is about to be carried out. A certificate of incorporation has recently been granted to the Susquehanna River Electric Company, and work is to be commenced as soon as the spring freshets are over. It is proposed to dam the Susquehanna River near Conowingo, Maryland, and erect a large electric power-house, similar to the one now in operation at Niagara Falls.

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The power obtained in this way will be supplied to Philadelphia, Wilmington, and Baltimore, and other intermediate points. It is expected that it will be used extensively in operating street railways and electric light plants.

Chesterfield and Midland Counties Institution of Engineers.—The next general meeting of the members of the institution (Mr. William Spencer, president) will be held in Leicester, in the Mayor's Parlour at the Town Hall, on Saturday, the 26th inst., at 2.30 p.m. The following papers will be open for discussion: "The Support of Buildings," by Mr. Wm. Spencer, F.G.S.; "The Use of Expansion Gear as applied to Colliery Engines," by Mr. M. Deacon; "Reports of the Royal Commission on Explosions from Coal Dust in Mines," and other papers on the subject; "Report of the Flameless Explosives Committee of the North of England Institute—Part I., Air and Combustible Gases," by Mr. A. C. Kayll; "An Underground Endless Rope at the Moston Colliery, Manchester," by Mr. H. Richardson Hewitt.

Electrical Fittings and Glass Ware.—Almost every kind of fitting for any particular purpose will be found in the new and illustrated list of fittings issued by the Electrical Company, Limited, of 122 and 124, Charing Cross-road, W.C. Polished brass electroliers occupy the first few pages, and the designs of these fittings and those on other pages are excellent in every way. The requirements of those who own or run billiard tables are amply fulfilled, the only pity being that the merits and advantages of electric lighting for billiard-rooms have not yet been fully appreciated. The list next deals with brackets and standards, and special designs in wrought-iron electroliers. Ceiling lights, counterweights, and cut-glass pendants, simple and fancy brackets, both in brass and wrought iron, figures, ship fittings, and fancy and cut-glass shades, conclude an interesting catalogue.

Mountain Railways.—It is of course not to be expected that the Institution of Civil Engineers, as the leading organisation in the engineering world, would be unable to get at the real facts of any problems or questions discussed at its meetings. Amongst so many engineers of repute the best methods and principles must soon come to the surface, and this was noticeable at the last meeting of the institution on Tuesday. The subject of the evening was that of "Mountain Railways," being a continuation of the discussion upon three papers read recently. Strong advocacy of electric traction for such lines was evidenced by members well qualified to speak on the subject, one going so far as to say that electrical working could be effected for half the cost of steam traction, owing, perhaps, very largely to the fact that water power is in nearly all cases of mountain lines both closely adjacent and readily applicable.

Phosphorescence and Photographic Action.—A discourse on "Phosphorescence and Photographic Action at the Temperature of Boiling Liquid Air," was given by Prof. Dewar before the Royal Institution on Friday. The lecturer showed experiments to prove that bodies which at ordinary temperatures are very faintly, if at all, phosphorescent glow very brightly if, after being cooled to the temperature of boiling liquid air, they are stimulated in the light of an electric lamp. Among the substances he experimented upon were cotton-wool, feathers, flowers, egg shells, quinine, acetic acid, and some of the complex platino-cyanides, the latter giving very brilliant effects. He proved experimentally that the stimulating power of the electric lamp lies chiefly, if not altogether, in its ultra-violet rays, and he showed the curious fact that the luminous and heat rays are able to dissipate the luminosity of a phosphorescing body in those parts upon which they have fallen. The latter part of the lecture was devoted to showing how greatly photographic action is diminished at exceedingly low temperatures—even to the extent of 80 per cent.

Shot-Firing by Electricity.—An interesting and well-illustrated pamphlet dealing with electric shot-firing has been issued by Nobel's Explosives Company, Limited, of Glasgow. This subject, to which we may refer again in a future issue, is treated in the pamphlet for the guidance of those engaged in the sinking of shafts, tunnelling, mining, and quarrying operations. One of the noteworthy points is quotations from various inspectors of coal mines, either recommending the adoption of electric shot-firing or speaking in high terms of the satisfaction which this method has already afforded. Apart from this, the report of the Royal Commission on Explosions from Coal Dust in Mines is mentioned as advocating the abolition of blasting-powder in such mines and the substitution of high explosives of the flameless type in conjunction with electric fuses. The pamphlet deserves the consideration of mine owners, civil engineers, and contractors.

City and Guilds of London Institute.—The act of distributing the diplomas, prizes, and certificates gained during the past year by the students at the colleges and schools founded and maintained by the City and Guilds of London Institute, was performed a week ago at the Fishmongers' Hall by the Marquis of Lorne. Among those present were Sir Evelyn Wood, V.C. (the prime warden of the company), the Wardens, Sir F. Bramwell, Sir Frederick Abel, Mr. E. L. Beckwith, Sir Owen Roberts, Sir Walter Prideaux, Dr. William Anderson, Mr. H. Rokeby Price, Prof. Henrici, Prof. Armstrong, Prof. Ayrton, Prof. Perry, Prof. Meldola; the Masters of the Mercers', Carpenters', Cutlers', and Waxchandlers' Companies; Prof. Unwin, Prof. Silvanus Thompson, Mr. J. C. L. Sparkes, Sir Philip Magnus, and Mr. J. Wrench Towse. After distributing the awards, the Marquis of Lorne said that technical education had now spread almost all over the country, and first and foremost among those who had helped the movement were the city guilds of London. He thought it was a question whether, this stage having now been reached, the Government should not come forward a little, not so much to promote, but to sort and order.

Distribution Concessions.—Animosity between gas and electric light does not appear to be confined in any way to the pages of English gas journals or even to this country at large. Several towns in France have discovered that they are in the very unpleasant position of being pledged to the gas interests so far as any system of underground distribution (or "canalisation," as they call it) is concerned, whilst they feel anxious to avail themselves of the enormous advantages offered by electric lighting. This state of affairs is now existing at Saint-Lô, and also at Cherbourg: and suggestions have already been made that the simplest way out of the difficulty is to string up overhead wires for the electric light service. Such a remedy for a harmful monopoly is, of course, obvious, but the municipal authorities of the above-mentioned towns are naturally hesitating to permit the use of overhead wires, not merely on technical grounds, but also because at Montauban (where similar conditions prevailed and where an overhead service was erected by permission) the local authorities have been condemned in heavy costs and penalties at the instance of the gas company. The matter has been taken to appeal, but meanwhile no movement can be wisely proposed.

Electric Lighting in Brussels.—We are glad to learn that the electric light in this town is now becoming

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widely adopted, thus necessitating an increase of the plant at the central station. An order for a third unit has been placed with the India Rubber, Gutta Percha, and Telegraph Works Company, of Silvertown, and it is expected that this will be erected early next month. Each unit is composed of one 600-h.p. slow-speed compound condensing engine and two continuous-current low-pressure dynamos, the distribution being on the three-wire system. The boiler plant is also being extended to meet this addition of machinery. The demand for light in the upper part of the town has exceeded expectations. It has therefore been decided to erect there an independent station, and the same company, acting as general contractors to the town, have been instructed to supply and erect the necessary plant, consisting of two 130-h.p. gas-engines, dynamos, cables, switchboard, etc., to meet immediate requirements. This satisfactory progress is no doubt due to the fact that the returns for the year's working already show a profit, although it will be remembered that the central station has only been in operation for little more than one year.

Development of Electric Railways. — Lord Kelvin distributed on Friday evening the prizes to the successful students at the Mechanics' Institute, Crewe. In the course of his address, Lord Kelvin emphasised the great value of technical training, not only because it helped young men to earn a livelihood, but for the pleasure and interest it would give them in their work. He said that in going through the great works at Crewe that day he had seen things which he should never forget. He was much struck with the great electrical developments which were going on. He himself took an intense interest in electricity, and it had been great pleasure to him to see electrical science become a great auxiliary in the work of mankind. He did not suggest it as probable, but it was possible, and it was a subject for enquiry and consideration, that dynamos might supersede steam in the working of their trains. Were that to come to pass, he did not think, from what he had seen, that the occupation of Mr. Webb or of Crewe workmen would be gone. The motto of Crewe was "Never Behind," and he did not think they would be behind in any such development. Mr. J. W. Webb, replying to Lord Kelvin's remark, said that if ever the London and North-Western Railway Company wanted a train to run by electricity they had only to give instructions, and he would undertake that it should be ready in two months.

Transformer-Chambers.—The *Journal of Gas Lighting* has climbed down and given in to the inevitable. This is what it says in regard to transformer-chambers: "The electric lighting companies of the Metropolis are to have their transformer-chambers under the streets, after all, provided these accommodation works are properly designed and constructed. We are not at all desirous of seeing the electricians hampered in their work by the insistance of the highway authorities on superfluous and pedantic restrictions ostensibly conceived in the interest of the public safety. At the same time there must be no question as to the obligation of the electricians to respect the prior and continuing rights of other users of the subsoil of the public streets. Naturally enough, the electricians exhibit a desire to throw upon other people's shoulders the blame of all street troubles connected with their plant and performances, and this is not precisely the way to make friends of those who must perforce be their neighbours. The gas companies bear them no malice, however, and are not even disposed to resent the petulant complainings of those who are without their experience in highway business; so that there is not likely to be unnecessary protesting on the part of the gas interests in regard to placing street transformer-chambers, but every instance will be dealt with strictly on its merits." "Prior and continuing rights of other users" is good.

Cooking by Electricity.—A description of Miss Fairclough's school of electrical cookery is given in *Black and White* of the 12th inst. Three good illustrations are shown of the apparatus at work and the messenger carrying out luncheons. The school was recently fitted up by Messrs. Crompton and Co., and during the few months it has been at work it has been very successful. The interviewer states that "the table (on which some of the apparatus was working) was an ordinary one of unpainted wood. Miss Fairclough stood behind it rolling pastry, while in front in a neat little row were six cooking utensils. All were of bright and shining copper and steel, from the kettle to the fluted 'griller,' and they simply stood on the table without any fire or apparent signs of heat. Yet there on the griller was a chop cooking gaily away 'with an independent air'; in the kettle water was boiling; on the hot-plate scones were toasting; in a frying-pan potatoes were frying; while two little pots were occupied by stewing bird and simmering jam. I noticed, too, that a bowl of chrysanthemums was not in the slightest degree disturbed by the neighbourhood of the kettle. The ovens, though not so startling in appearance, were soon proved to my satisfaction to be equally delightful. Each one contains six shelves, which admit of an infinite variety of roastings and bakings going on at the same time, and as the ovens heated by electricity retain their warmth for an almost incredible time after the electric current has been removed, their many advantages need no recounting. I pondered many things, and finally concluded that could all kitchens be made as ideal as Miss Fairclough's electrically-heated one, even the cook might find a chance to become a 'new woman.'"

Parker's Continuous-Current Dynamos.—In our issue of the 11th inst. we described some of the features of the new design of continuous-current dynamo introduced by Messrs. Thomas Parker, Limited, of Wolverhampton. The company have now sent us a copy of their illustrated catalogue of these machines, the special features of which, it will be remembered, are the use of hinged pole-pieces so that the armature can be readily examined and taken out by a vertical lift, and the employment of the Eickemeyer method of winding the armature. It may be as well to recall the fact that this system of winding the armature ensures perfect insulation and electrical and mechanical balance, every coil on an armature consisting of exactly the same length of wire, without any soldered joints. The coils are wound separately on formers thoroughly insulated, and afterwards threaded on to the armature core; they can easily be removed, and a damaged one can be replaced by another without entirely rewinding the armature. There is no difficulty by the use of the Eickemeyer system of winding in constructing dynamos at any E.M.F. up to 2,000 volts. The list gives details of machines built for giving voltages ranging from 52, 70, 105, 140, 210, to 525 volts. The total bearing surface of the dynamos is at least six times the diameter of the shaft. The bearings are lined with a special mixture of white metal, and each is provided with an oil well and ring, giving a continuous lubrication. After passing along the bearings the oil is thrown off by grooves in the shaft into chambers at the ends of the bearings, from which it is conducted back into the oil-well. The machines can be operated equally well as motors or as dynamos.

The Arc Lamp.—The second Cantor lecture on this subject was delivered on Monday by Prof. Silvanus P. Thompson at the Society of Arts. The lecturer discussed the optics of the electric arc. He stated that most of the

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total light is given off from the crater, less than 10 per cent. coming from the peak. The crater may be regarded as a flat self-luminous area. If it could be seen in such a way that the peak never came between it and the eye, it would give the greatest light when looked at perpendicularly and the least when the line of vision was horizontal with its surface. But the shadow of the peak has to be reckoned with, and it is found that the light given off is directly proportional to the area of crater actually exposed to view, being greatest at an angle of 40deg. or 50deg. In the middle of the crater there may sometimes be discovered with the unaided eye a nebulous patch, rather whiter than the rest, which seems to be in motion. By the use of appropriate artificial means this patch may be seen as a comma-shaped object which rotates round the crater at very varying speeds, and not always in the same direction. It is a question whether this is a true physical rotation of the flame or only an optical effect. As to the efficiency of the arc regarded as a means of transforming energy into light the lecturer said that of all the rays given off by it only 20 or 25 per cent. are visible to the eye, the rest of the energy consumed being transformed into heat. He then showed an arc formed by an alternate current, and pointed out that the light from it is more equably distributed than that from the continuous-current arc. He thought it absurd to suppose there would be any difference in efficiency between the two, if the same amount of energy were consumed under equal conditions.

Terrestrial Magnetism.—A paper on this subject was presented to the Royal Geographical Society on Tuesday by Prof. A. W. Rücker, F.R.S. In the course of the paper the author stated that about 50 years ago the science of terrestrial magnetism attracted general attention, and then the interest felt in it waned. Of late, however, throughout Europe and the United States, the magnetic state of the earth has been studied with a minute accuracy never before attained. The result was that new problems had been suggested, in the solution of which travellers could do much. Dr. Thorpe and himself, in the survey of the United Kingdom, had determined the magnetic elements at about 860 places. This made the magnetic survey of this country the most complete and detailed that had ever been accomplished. The results proved that, even when the surface soil was non-magnetic, there were lines towards which the magnet was attracted. This effect was chiefly due to concealed masses of magnetic rocks. In this country there was no relation between the abnormal behaviour of the needle and the distribution of rocks of later date than the carboniferous period. In the case of the older rocks there was an unquestionable, though somewhat irregular, connection between regions of geological upheaval and lines to which the north pole of the magnet was attracted. The fact that the amount by which the needle pointed away from true north was continually changing, was at one time ascribed to a motion of the magnetic poles or foci. There was no evidence of any such movement during the last 40 years, and it was open to question whether it really occurred. The position of the south magnetic pole had been fixed in 1840 by Ross, but had not been redetermined. An antarctic expedition to investigate the magnetic conditions of the southern seas was needed to supply science with the facts upon which alone a theory of the magnetic constitution of the earth could be built.

Incandescent Lamps for Explosive Factories.—In the course of his concluding lecture to the Society of Arts on "Explosives and their Modern Development," Prof. Vivian B. Lewes referred to the use of incandescent lamps. He said: "It is not long since that a high authority on explosive matters regretted that there was not such a thing as an electric lamp which could be looked upon as perfectly safe for use in explosive factories or in fiery mines, and in concluding my subject to-night I should like to draw your attention to one which has been devised in order to meet these requirements, and which, having been exhaustively tested with regard to its safety, has been largely used at one of the South Metropolitan gasworks for such dangerous operations as cleaning the interior of gasholders, tanks, purifiers, etc. It consists of an incandescent lamp mounted upon the end of a short glass tube. In the middle of the tube is sealed a platinum disc in such a way as to be gastight. To the disc is attached a metal spring leading to one terminal, and the other terminal is connected to a wire which passes outside the glass tube, and is sealed into the outer enclosing glass envelope, which surrounds the whole of the lamp and half the glass tube, communication having been previously established between the interior of the tube and the outer envelope by means of a hole in the tube. In the outer half of the tube a platinum wire is inserted and adjusted in such a way that when air is forced into the outer envelope, the platinum disc is depressed and makes contact with this wire. The lamp thus made consists of two gastight divisions separated by the disc, the larger one containing the lamp, one terminal, and half length of glass tube, the other and smaller one containing the platinum wire. Air, or an inert gas, under pressure is sealed up in the outer envelope, causing the disc to be depressed, thus making contact with the wire, and enabling the current to pass. If the outer envelope be broken the air escapes, the platform disc resumes its flat condition, and contact is broken, any sparking that may arise on the rupture of the current being confined to the smaller gastight division, thus obviating any risk of igniting inflammable gaseous mixtures. Instead of introducing air under pressure in the outer envelope, a vacuum may be formed, when the connections between the disc and wire will have to be altered accordingly."

Electric Motor Work.—The electrical industry owes already some considerable amount to the new President of the Institution, but this debt is still more increased by his presidential address, and more particularly by those paragraphs wherein he points out very clearly the enormous advantage of electric motors in numerous industrial operations, not merely for giving a day load to central supply stations, and so helping to level the entire load curve, but also for securing a great economy of power to the consumer in work of a transient nature. Of course, the latter point, so far as electrical engineers are concerned, serves more especially as an outside argument to induce consumers to adopt electric power in their workshops. The question of a day load, however, appeals essentially to central-station men, and rightly merits their special consideration. In towns and cities like Birmingham, for instance, there are hundreds of workshops where electric motors might be installed with great advantage and economy, using up a large proportion of the central-station output for the whole day, and therefore helping to spread the load more evenly so as to run the central-station plant very economically. With regard to at least one staple trade of the Birmingham district (though not of course confined exclusively to the Midlands, since the first experiments have been made in London)—viz., that of cartridge manufacture—a series of valuable improvements in the machinery employed has just been completed by the Electrical Installation Company, Limited, of 64, Victoria-street, Westminster, S.W. This company was requested by the well-known gunmaker, Mr. Charles Lancaster, to arrange one of his cartridge-closing machines

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for operation by an electric motor. This necessitated, or at least led to, some additional devices by means of which the entire process is carried out automatically, at a great saving of time and trouble. Average workmen can now do three times as much with the new type of electrically-driven machines as with the old form, wherein hand labour was largely used. Although, of course, the machines can be operated by steam power or any other mechanical method, it is obvious that the discontinuous use to which they are put in practical every-day service must render the employment of electricity by far the most economical method of working: and in this respect alone the Electrical Installation Company is much to be congratulated for showing its advantages. Every single instance of a new opening for useful work of electric motors will serve to spread their benefits still more widely, and central-station authorities owe a debt of gratitude to those who work in this direction.

Illuminating Hydro-Carbons.—A paper was read recently before the Society of Arts by Prof. Vivian B. Lewes dealing with the "Commercial Synthesis of Illuminating Hydro-Carbons." In the course of the paper the author said: "Whilst working with an electric furnace, and endeavouring by its aid to form an alloy of calcium from some of its compounds, Mr. T. L. Willson noticed that a mixture containing lime and powdered anthracite, under the influence of the temperature of the arc, fused down to a heavy semi-metallic mass, which having been examined and found not to be the substance sought was thrown into a bucket containing water, with the result that violent effervescence of the water marked the rapid evolution of a gas, the overwhelming odour of which enforced attention to its presence, and which, on the application of a light, burnt with a smoky but luminous flame. Investigation into the cause of this phenomenon soon showed that in a properly constructed electric furnace, finely ground up chalk or lime mixed with powdered carbon in any form, whether it were charcoal, anthracite, coke, coal, or graphite, can be fused with the formation of the compound known as calcic carbide, containing 40 parts by weight of the element calcium, the basis of lime, and 24 parts by weight of carbon, and that on the addition to this of water a double decomposition takes place, the oxygen of the water combining with the calcium of the calcic carbide to form calcic oxide or lime, whilst the hydrogen unites with the carbon of the calcic carbide to form acetylene, the cost of the gas so produced bringing it not only within the range of commercial possibilities for use *per se*, but also the building up from it of a host of other compounds, whilst the production of the calcic carbide from chalk and from any form of carbon renders us practically independent of coal and oil, and places in our hand the prime factor by which Nature in all probability produces those great underground storehouses of liquid fuel upon which the world is so largely drawing to-day. Wonderfully and intensely interesting as is the train of thought opened up by the discovery of this substance and its commercial production, the object I have in view this evening is not to discuss theoretic possibilities, but to show you the important effect which it will have in the direction of our great gas industry, and the phase of this which I wish to deal with specially is the value of acetylene, either for producing *per se* an enormously high illuminating effect or for the enrichment of low-grade coal gas. When the calcic carbide is placed in a glass flask, and water allowed to slowly drip upon it from a dropping tube, the decomposition at once commences with considerable rapidity, and the acetylene pours off in a continuous stream; as the decomposition continues, the solid mass in the flask swells up, and is eventually converted into a mass of slaked lime. For commercial purposes, the carbide will be cast direct from the electric furnace into rods or cylindrical cartridges, which, when 12in. long and 1¼in. in diameter, will weigh 1lb., and will give five cubic feet of gas."

Belfast Central Station.—The municipal station, which lies between Marquis-street and Chapel-lane, is now ready for supplying current to consumers. The station has been designed and the mains laid according to the scheme prepared by Prof. Alex. B. W. Kennedy, who has acted as consulting engineer to the Corporation. The plant comprises direct-current dynamos driven by gas-engines, the latter being worked by gas obtained from the city mains. By this means it has been possible to erect a station in the centre of the city, but occupying much less space than would have been necessary had steam-engines and boilers been employed. There are six gas-engines, each driving a dynamo by ropes. Four of the engines indicate 100 h.p. each, and two indicate 50 h.p. All the engines are double-acting and the largest are of the tandem type, in order to get a maximum of steadiness in the drive. The engines and dynamos occupy the greater part of a space 86ft. by 40ft., which forms the main engine-room. At the north end is arranged the switchboard, which carries all the regulating apparatus. In a room behind the switchboard is placed a battery of accumulators. The capacity of this battery is such that it can keep 3,000 lamps of 8 c.p. alight for one hour, or 600 lamps continuously for five hours. It will be charged from the dynamos, and once charged it can be discharged during the night and the light hours of the following day. In this way it will only be necessary, it is expected, to run the engines and dynamos for seven or eight hours daily during at least the greater part of the year. This matter of supplying light without running the engines is of importance, especially in Belfast, where, on account of the long summer days, the amount of lighting during a large part of the year is extremely small. The three-wire system has been adopted. The mains are laid underground, and for the most part they consist of bare copper strip arranged on stoneware insulators in concrete culverts. Prof. Kennedy's estimate of the cost of the scheme to the extent to which it is at present carried out, but exclusive of land, buildings, and meters, was £19,000. The plant was intended to be sufficient for keeping 6,100 lamps of 8 c.p. alight simultaneously, with ample reserve. The actual cost of the plant and mains as laid down has been considerably under the estimate. Mr. Charles C. Connor, M.P., who was chairman of committee at the initiation of the scheme, took the greatest interest in it, and it has been carried out under the present chairman, Alderman Pirrie. The specifications were drawn up by Prof. Kennedy, under whom the work has been carried out. Mr. C. Stanley Peach, of London, designed the buildiugs. Mr. V. A. H. M'Cowen was appointed electrical engineer to the Corporation in April last, and has personally superintended the carrying out of the work in the city since that time. The principal contractors were: buildings, Messrs. M'Laughlin and Harvey; engines, Messrs. Dick, Kerr, and Co.; dynamos, Messrs. Siemens Bros.; switchboard, Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne; batteries, the Electrical Power Storage Company; copper strip, Messrs. Curtis and Sons, of Dublin; insulated cable, Callender's Bitumen Company; the cast-iron work, Messrs. Robert M'Laren and Co., of Glasgow; and roadwork, Messrs. Scott and Sellar, of Aberdeen.

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THE PREVENTION OF EXPLOSIONS IN CONNECTION WITH UNDERGROUND MAINS.

VIEWS OF CENTRAL-STATION ENGINEERS.

One of the most important questions in connection with the supply of electrical energy from central stations—as we pointed out in this journal a few years ago, and as we have frequently insisted upon—is the subject of efficiently ventilating underground culverts and pipes, so as to avoid the contingency of explosions through the accumulation of coal gas. This question, it is scarcely necessary to mention, has now become one of, if not the most, absorbing subject of the day in central-station working. Our views on the subject have been fully borne out by the street occurrences during the past two or three years, and we are glad to have been instrumental in pointing out probable faults and suggesting remedies, the latter of which have in many cases been adopted.

Recent events have rendered it necessary to place before the electrical industry at large—and particularly central-station engineers, borough and consulting engineers, corporations who have erected electricity works, and those local authorities who propose or who are thinking of establishing such works—the exact position of underground systems in regard to the precautions taken to avoid, or at all events minimise, the possibility of explosions in connection with these systems. We accordingly invited the co-operation of central-station engineers in this matter, and our best thanks are due to them for so kindly responding to the following questions. We give below the first instalment of the replies, or rather their substance.

(1) Have you had any trouble or explosions through the accumulation of gas in conduits or pipes?

(2) If so, what method of overcoming the difficulty has been adopted or suggested?

(3) In the former case has the method been successful?

(4) Have you adopted any system or ventilation; if so, of what nature is it, and what have been the results?

(5) What do you consider to be the most practical method of preventing explosions in (*a*) conduit and (*b*) in pipe systems?

(6) Has there been any trouble through electrolysis?

(7) What system of draining the culverts has been adopted?

Bath.

Mr. G. F. METZGER, chief engineer of the Bath Electric Light Company, remarks that their mains are laid on the Callender solid system. No culverts or pipes are used, and the dangers of explosions through gas leakages and electrolysis are averted. The company have never had any trouble from these causes.

Bolton.

Mr. JOHN H. RIDER, the electrical engineer, has had no difficulty in the way of explosions. The sub-stations are ventilated, and the cast-iron pipes carrying the high-tension wires are to a certain extent ventilated therefrom. Mr. Rider opines that forced-air ventilation from the station end is the most practical, each manhole having a vent to the atmosphere. The best way is to only put down armoured cables. There are no culverts in Bolton, the sub-stations being drained through 6in. trap to sewer. Electrolysis is unknown.

Bournemouth.

Mr. H. M. SAYERS, the engineer to the Bournemouth Supply Company, observes that he has personally had no trouble through gas, although he has been in charge of underground mains for nine years in three different towns. In Bournemouth, there were several explosions of gas in pipes and junction-boxes before he took charge. Since then, and the use of concentric cables, none have occurred. Upcast ventilating tubes have been put in at some points and ventilating grids at others, but principally endeavours have been made to keep the cables up to high insulation and to hermetically seal buried fuse-boxes which might ignite explosive mixtures. The use of concentric cables and sealed fuse-boxes are probably the main causes of recent freedom from trouble. Mr. Sayers says that coal gas is sometimes smelt even near ventilators. It is doubtful, he states, whether a tall upcast pipe may not suck gas in through leaky pipe joints and loose walls and floors. In conduit systems (of which he has no personal experience) he thinks that grids flush with pavement, with catchpits, and opening into top of conduit, should prevent gas explosions; in pipes, maintenance of the insulation at a high figure. No doubt gas can be kept out by maintaining a positive air pressure in pipes, but this is expensive. With alternating currents concentric cables alone are free from risk of sparking, and then only while the outer insulation is good. There is no appreciable electrolysis with alternating currents. He has had some trouble on a three-wire direct-current system, any fault in a positive conductor resulting in its oxidation and parting. Bare-strip systems are sure to show copper salts on positive insulators sooner or later, especially if in a three or five-wire system the neutral conductor is earthed. Mr. Sayers does not believe in the possibility of explosions from electrolysis. The pipes in Bournemouth drain through the bottoms of the junction-boxes, the soil being sandy and bricks left uncemented purposely. With considerable difference of level, such as exist in many towns, any connection to the sewers is more likely to cause trouble than to prevent it.

Bradford.

Mr. S. W. BAYNES, the electrical engineer, is of opinion that explosions are due to short-circuits, and not to gas. He recalls the fact that he was the first to use and introduce bare conductors in culverts.

Burton-on-Trent.

Mr. F. L. RAMSDEN, the manager and engineer of the Corporation gas and electric light station, states that they have high and low pressure mains, in cast-iron pipes, and underground transformers. They have had no trouble with gas getting into the pipes or boxes.

Burnley.

Mr. F. THURSFIELD, the electrical engineer, reports that the Corporation have no pipes or culverts in the town.

Chelmsford.

Mr. H. B. PRICE, the electrical engineer to the Chelmsford Electric Lighting Company, Limited, states that gas has not caused any explosions, and that there has been no trouble through its presence. The system used is fairly ventilated through the iron lamp-poles and the poles which connect the overhead and underground mains. Ventilation and frequent inspection are considered to be the most practical method of preventing explosions. There has been no difficulty through electrolysis. Mr. Price further says that the Doulton casing, which the company use, keeps water out fairly if carefully laid. The floors of all their transformer pits are laid on a slope to let any water that may collect run into a well under the pavement box. These pits are frequently inspected and any water removed.

Charing Cross and Strand.

Mr. W. H. PATCHELL, chief engineer to the Charing Cross and Strand Electricity Supply Corporation, replies in the negative to the first three questions. A system of thorough and continuous ventilation and inspection has been adopted with satisfactory results. Thorough ventilation is regarded by Mr. Patchell as the most practical method of preventing explosions. With regard to drainage, Callender casings and brick-built boxes are used. Leakage is very slight; when it occurs it is baled out of a small sump. There has been no trouble through electrolysis.

Coatbridge.

Mr. FRANCIS TEAGUE, engineer and manager of the Coatbridge station, observes that no difficulty has been experienced through the accumulation of gas. Concerning ventilation, they have inserted a grating in the cover of each transformer-chamber, and thorough ventilation has been introduced. There are no culverts, but the transformer-chambers have each a trapped drain connected with main sewer. The high-tension mains are run through cast-iron pipes, P. O. pattern, which are gas and water proof, the ends of same being open at each chamber. All the

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low-tension mains are filled in solid with bitumen, and have given every satisfaction. There has been no difficulty through electrolysis.

Derby.

Mr. J. E. STEWART, electrical engineer to the Corporation, reports that no explosions have taken place. The method of ventilation adopted is that of ventilating the ground, where possible, by and where arc lamp-posts occur. The best method of preventing explosions is "to charge the gas company with the expenses and damages." No trouble has been experienced through electrolysis. Short iron drain pipes 3in. in diameter are driven into the subsoil at each box, and no trouble in getting rid of water has been found.

Dewsbury.

Mr. JOHN B. MITCHELL, the Corporation electrical engineer, writes that nothing in use there is concerned by any of the questions. The system of mains used is Siemens triple concentric for feeders, whilst the distributing mains are single core. All the mains are buried in the earth; there are no conduits, and consequently there is no trouble of the kind mentioned in the queries.

Halifax.

Mr. P. WILMSHURST, the Corporation electrical engineer, has experienced no trouble through gas. Concerning the question of ventilation, he states that they make a practice of opening several draw-boxes every week, and if any trace of gas exists the boxes are left open for several hours. A system of ventilating shafts at intervals run up house-sides or lamp-posts, and dry air pumped into the conduits, if necessary, is regarded as the most practical method of avoiding explosions. A sump is fixed in each draw-box, which effectually drains the pipes and boxes. Electrolysis has not caused any trouble.

Hampstead.

Mr. R. A CHATTOCK, electrical engineer to the Vestry of Hampstead, observes that there has been no trouble or explosions caused through the accumulation of gas. Precautions are, however, taken by fitting a grating at the top of the transformer sub-stations. In this case the results have been perfectly satisfactory, no trace of gas ever being noticed in the sub-stations. Mr. Chattock considers that the most practical method of preventing explosions is to build the conduits on a slope, and put ventilated pockets, at not more than 100 yards apart, in the under side of roofing, and to efficiently plug the pipes at the entrance to each manhole, and to use no pipes larger than 5in. diameter. The system of draining consists in placing traps beneath the gratings, so as to catch water, and a sump being arranged at the bottom, to be emptied periodically.

Hanley.

Mr. GEO. H. COTTAM, the electrical engineer, says that no trouble has arisen through gas. With regard to ventilation, the transformer-chambers have 6in. inlet and 6in. outlet ventilating-pipes. Ventilation is the most practical method. All the chambers and many of the boxes have drains connecting through traps to the sewers. No difficulty has been found through electrolysis.

Lancaster.

Mr. A. S. BARNARD, the borough electrical engineer, states that there has been no trouble or explosions experienced through the accumulation of gas in connection with their mains, which are laid on the Callender-Webber system. No systematic system of ventilation has been adopted, but several vertical pipes rising out of the junction-boxes in different parts of the town, and which to a certain extent act as ventilators, have been erected. No difficulty has been found through electrolysis. With regard to drainage of the culverts, the surface water is carefully excluded, and very little trouble has been experienced. The junction-boxes are not watertight at the bottom, but are merely loose rubble. Any little water which enters the culverts soaks away into the soil from the junction-boxes.

Kingston-upon-Thames.

Mr. J. E. EDGCOME, the borough electrical engineer, informs us that they do not use conduits or pipes in the Kingston system, all the mains being concentric-armoured cables laid direct in the ground. It is therefore impossible for them to be troubled with explosions through gas of any kind being fired by electric sparks.

Leeds.

Mr. H. DICKINSON, the engineer to the Yorkshire House-to-House Electricity Company, reports that the company have had no trouble in regard to explosions. With regard to ventilation, he states that the surface boxes allow the gas to pass out through the lid, as the joint is not made watertight. The most practical method to adopt is to prevent the accumulation of gas by means of ventilation, and, if possible, in pipe systems to keep out the gas altogether. The manholes at the lowest points are connected to the main drains. No trouble has arisen through electrolysis.

Londonderry.

Mr. JOHN CHRISTIE, the resident engineer, states that no trouble has arisen through gas, the mains being armoured cables laid direct in the ground. With regard to the prevention of explosions in conduit systems, Mr. Christie considers that the most practical method is to use Doulton stoneware conduits, with manholes, treated as first suggested by Mr. Lewis at Hull.

Notting Hill.

Mr. GEO. SCHULTZ, the electrical engineer to the Notting Hill Company, says that no trouble has been experienced in regard to gas. The difficulty is overcome by lifting the covers and ventilating. No special arrangements have been adopted to ventilate the culverts. Ventilation from the lowest to the highest points of culverts and pipes is regarded by Mr. Schultz as the best method, whilst the culverts are drained into the main sewers. No trouble has been experienced through electrolysis.

Reading.

Mr. F. F. YEATMAN, the manager of the Reading Electric Supply Company, Limited, states that the mains in use are at present arranged overhead. Underground mains are, however, now being laid on the Callender system.

Southport.

Mr. ARTHUR ELLIS, the municipal electrical engineer, remarks that armoured concentric cables are used, and that consequently none of the troubles referred to in the questions take place. The cables are laid direct in the ground. The system is alternating. Where he has used pipes, etc, Mr. Ellis has generally adopted a Thwaites blower for forcing dry air throughout the system.

HIGH-TENSION CABLE TESTS.

(Communicated.)

A minor point in the general question of satisfactory cable insulation has lately been raised with regard to the proper testing of high-pressure direct-current cables—such as are employed for arc lighting and power transmission—with an E.M.F. of 2,000 volts or more. The majority of responsible makers of insulated wire and cables very rightly make a strong feature of their qualifications to supply good material by saying that all their cables are tested to, it may be, double the working voltage normally employed, so that any defects of manufacture may be found out at the works and at once remedied. This is an excellent plan so far as it goes, and should offer no difficulties in carrying out in the case of cables for alternating-current use, since any desired pressure can be obtained by means of transformers, but the proper testing of continuous-current cables would not appear quite so easy.

Is it satisfactory enough to use high-pressure *alternating* currents for the latter kind of test instead of direct currents? Yet it may be doubted whether direct currents from a dynamo at pressures of 4,000 or more volts are in regular use for continual testing of cables, for the difficulties of insulation in the machine itself are notorious. The mechanical strain in a cable used for a 2,000-volt direct current is probably not the same as that in a similar

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cable used for alternating currents of like pressure, either in character or results, so far as one may judge from present knowledge, and an alternating-current temporary test of 5,000 volts may not develop faults which the continued application of a 2,000-volt direct current would find in a cable. Of course, a battery of cells—of sufficiently huge quantity—might furnish the required pressure, but the current would in such a case be only a fraction of that employed under normal working conditions, and the effect of full current in heating the cable is not to be lost sight of as a fault-developer.

Continuous-current machines capable of developing a pressure of 5,000, or even 10,000, volts are not only conceivable, but have even been constructed; and their use might advantageously be extended, not only for testing purposes, but also for experimenting upon much higher direct-current voltages than we have so far been familiar with. There *may* possibly chance to be some discoveries yet to be made in this connection, of no small value for industrial purposes.

SPARKING OF CLOSED-COIL DYNAMOS.*

BY GEORGE T. HANCHETT.

This most fruitful source of trouble and annoyance to the average station engineer is much more readily met if a knowledge of the causes and remedies is available. To some extent a closed-coil commutator requires a certain amount of care, closely akin to what in common parlance is termed "monkeying"—that is, the application of certain adjustments and combination of brushes and pressure on the commutator for no other good reason than that they stop the sparking. But it is also true that there are certain technical points which have a general application to closed-coil dynamos, and which cannot be neglected if sparkless running is to be understood.

In a closed-coil dynamo, whether drum or ring, the current approaches the brush in two directions from the two halves of the armature. This is shown in Fig. 1. In the figure are shown the commutator bars. Between every commutator bar is a loop of wire so wound around the armature core as to assist in producing E.M.F. when the armature is in motion in its field.

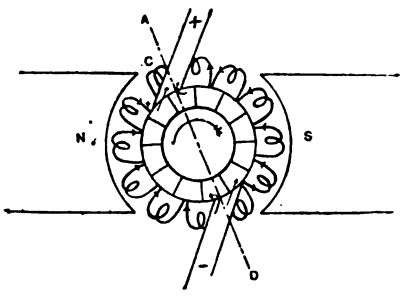

FIG. 1.

Various inventors give these loops peculiar forms and connect in different ways, but the principle is in each case the same. It is evident that the bobbins on either side of the brush are of opposite polarity, and hence both send the current toward the brush in the direction of the arrows. The coil, C, is momentarily short-circuited by the brush, and whatever the direction of its E.M.F., when delivered to the north side of the armature, the current in it will flow toward the brush. If, therefore, it is released before it gets well out of the south field, the E.M.F. in the bobbin will be in opposition to the current that is forced through it by the other bobbins, and rather than instantly establish the full current in the resisting bobbin a bright spark will occur at *x*. If we rock the brush forward until the bobbin, *c*, clears the south field, and is discharged upon the north side empty of all current, we shall have bettered matters somewhat, but since it takes time to establish current in a coil wound about iron, or, in other words, such a coil is self-inductive, a spark will still occur at *x*, although a smaller spark than in the first case. If now we rock the brush so far forward that the bobbin *c* enters the north field sufficiently to establish in it a current equal to and in the same direction as the full current in that side of the armature where it is released, there should be no spark at *x*.

In a well-designed dynamo the amount that the brush should be rocked past the neutral line is very small. The bobbin is of low resistance and the field is strong. All the E.M.F. generated is used in establishing this current in the bobbin. If the bobbin is well short-circuited, only a fraction of a volt is necessary. Hence, if a carbon or high-resistance brush is used it must have a thicker bearing surface than a low-resistance copper brush, for the commutating bobbin must be swung further into the north field before the necessary current is established therein. It is possible to secure sparklessness by short-circuiting *c* for a shorter length of time in a stronger field by rocking the thin high-resistance brush still further forward, but this tends to throw bobbins with reverse E.M.F. on the south side of the machine, which makes the machine work against itself and reduces the output. The bobbin should be short-circuited by the brush the instant it ceases to have E.M.F., and the brush should have thickness of bearing surface enough to hold it thus until the full current is established in the reverse direction. It is easy to see that the higher the resistance of the brush the more thickness of bearing surface it should have.

On general principles this is so, because the area of contact should be greater in order to transmit the main current. This may be remedied by increasing the breadth of the brush, but to properly commutate the bobbin, the brush of higher resistance should have increased thickness as well. A little consideration will show that while one set of brushes may be set correctly the other is not necessarily so. In a good bipolar machine the brushes are diametrically opposite. However, the field magnets may not establish a uniform field, and in that case diametrically opposite brushes will secure sparkless running for only one set of brushes. The other set must be set to the magnetic rather than the geometrical point of non-sparking. When the load of such a machine changes, and both brushes spark in consequence, mere rocking of the brushes will correct only one set. The other must be adjusted as before, and hence such a machine is an endless source of trouble. This fault is more liable to occur with ring than with drum armatures.

Having thus obtained an idea of the way a bobbin is reversed under the brush, we are in a position to consider the various causes of sparking and their remedies. There are several distinct kinds of sparks which appear at the brushes of a closed-coil dynamo. First, those due to an imperfectly commutated bobbin, which are of a bluish, flashy nature. These are not very destructive to the commutator. Second, those due to imperfect or insufficient contact. These are of a deep yellowish-red colour, and cut deep ruts in the commutator if allowed to continue. These two are liable to appear on a dynamo in the best of order. There are also intermittent sparks due to a local defect in the armature. To a man not familiar with the two different kinds of sparks, their distinction is a little puzzling. The spark of the improperly-commutated bobbin may be produced by rocking the brushes out of position. The second kind may be produced by applying an excess of oil to the commutator with the brushes set correctly.

The writer does not advised any prolonged experiments of this nature with a nicely polished commutator. The information may in such a case cost too dear. It is, however, important to distinguish between the sparks in order that the correct remedies may be applied. The bluish spark, due to an improperly commutated bobbin, is due only to incorrect position of the brush on the commutator. Even a thin brush, if not too thin, may be given sufficient lead to stop this sparking. If the field is unsymmetrical, as is sometimes the case, each set of brushes must be set separately at each change of load. An expert designer can often correct an unsymmetrical field by properly shaping the pole-pieces.

The other kind of sparking is due to difficulties of a mechanical nature. A rough, uneven commutator may cause the brushes to jump and spark. If the commutator

* From the *Electrical World* (New York).

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is not very rough, sand-paper may be used to smooth it, but if the commutator is very rough there is no remedy but to turn it down. Oil or foreign substance sometimes causes sparking. The heat caused by the current will vaporise the oil under the brush and make a poor contact worse. The remedy is obvious. If the current is so great as to cause a heavy overload, the brushes will spark. This, of course, is not the fault of the dynamo, and efforts should be made to reduce the load. If the brushes spark intermittently, keeping step with the revolutions of the dynamo, there is a local defect in the armature. This may be due to one of the commutator bars being too high or too low, or to a loose bar. In the case of a high bar, see if it is not also loose by gently tapping it with a mallet. If it drives back with light blows, tighten the retaining rings. Never drive a bar back into position by a heavy blow, as the insulation may be damaged. In the case of a low bar tighten the commutator rings, if necessary, and turn down true. High, low, and loose bars occur only in very poorly-made commutors. It sometimes happens that the connection of a single bar has become loosened or broken, due to centrifugal force, magnetic drag, or both. This will cause an intermittent spark. If the commutator is truly round and smooth, the bar at fault may be distinguished from the fact that the bar in front is bitten away by the intermittent spark. This should be remedied at once, for that bar may become lower than the rest and a "flat" be produced.

In general, sparking will be avoided if the following suggestions are followed. The commutator should be true, smooth, well made, and of good material, and free from local defects. The brush should have a smooth, well-trimmed surface, with no frayed ends to make a loose contact. It should have sufficient area of contact to carry the current. It should have sufficient depth of contact to properly commutate the bobbin. In the case of a set of brushes this may be secured by leading one brush a little in advance of the others. This is indeed often done. Experiment is the best guide as to how much this brush should be led. The brushes should be set in the proper position on the commutator. Pressure of the brushes on the commutator should be just enough to stop the sparking and no more. The lighter the touch of the brush on the commutator consistently with no spark the better. Most closed-coil commutators run better with a very little oil. It should be applied very cautiously with a bit of felt. No commutator of this type does well with an excess of oil, and a few run better without any. Experience is here the best guide. Some manufacturers put poor insulation into their commutators. These men frown upon the use of any oil at all for obvious reasons.

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 24.

MR. R. E. B. CROMPTON (President) in the chair.

At last night's meeting of the Institution the following candidates were balloted for:

Member.—Horace F. Parshall, 38, Parliament-street, London.

Associates.—Alfred John Beaumont, 6, Scarcroft-road, York; Isaac William Chubb, 104, Royal-road, Kennington Park, S.E.; William John Corse, 17, Old Town-street, Plymouth; Rowland Edward Dixon, care of Messrs. S. Dixon and Son, electrical engineers, Leeds; John Alfred Edmondson, 23, Charles-street, Bradford; Charles Parkin Goode, 6, Lombard-street, London; R. Holiday, Acton Hall Colliery, Featherstone, near Pontefract; Frank B. Holt, 4, Leacroft-road, Derby; Alfred Edward Jackson, 26, Bramerton street, Chelsea, S.W.; John Ranald Macdonald, The Priory, Salisbury, Wilts; Oscar Albert Pilcher, 26, Percy-circus, King's Cross-road, W.C.; Harold Whiteman Woodall, "Thornlea," Fitz John's-avenue, N.W.; Frederick William Wheadon, 16, Geneva-road, Brixton, S.W.

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The following paper was then read on:

The Origin and Development of the Telephone Switchboard.

BY J. E. KINGSBURY, ASSOCIATE.

The telephone itself has been the subject of various papers read before this Institution, but the same remark does not apply to apparatus which has become allied with the telephone in its commercial applications. The most important of such apparatus is the switchboard used in exchange service. It is because this subject does not appear among your records that I have treated it in the manner indicated by the title of this paper. To those who have been long engaged in telephone work such a title will not raise expectations of novel information, or suggest exhaustive treatment. To those who are not so engaged I can only hope that it may be of interest to the same extent that it is of interest to trace the development of any enterprise or apparatus.

The switchboard has been described as the brain of the telephone system. In seeking anatomical similes I hardly know whether to choose the brain, the heart, or the backbone. It is the brain in so far that it is the nerve centre, all communications going through it; it is the heart in that it is the life of the telephone system as we know it to-day; and it is certainly the backbone—of the exchange business.

The telephone, itself a marvel of simplicity, has become involved in a network of considerable complexity known as an "exchange system"—a means of intercommunication of which the switchboard is the centre-piece. The exchange system seems necessarily identified with the telephone, but it existed before the telephone was invented.

I am indebted to American sources for the information that the first idea of exchange working is to be found in a British patent granted to an inventor bearing a French name. Mr. T. D. Lockwood says: "The first idea of exchange work which to my knowledge occurs in history is found in a British patent issued as far back as February 7, 1851, to F. M. A. Dumont. This clearly describes an exchange system of dial telegraph instruments, connecting by short lines with branch central stations, which branch stations were provided with trunk lines connecting them with a principal station." Mr. Lockwood remarks that "the idea was far ahead of the times."—(Tel. Con. Rep., 1887, p. 50.)

At Newcastle the Post Office arranged a system of connecting subscribers provided with Wheatstone A B C instruments. In New York such a system was introduced in 1874 or 1875. The founder of that system was not aware that intercommunicating exchanges had previously existed. He had observed the success attending the telegraphing of stock quotations to subscribers, who each received identical information despatched from a central office, and he assumed that a like success might be obtained by furnishing information to legal firms as to the course of proceedings in the Courts. The legal firms did not take kindly to the idea, but one of them offered an alternative suggestion, intimating that a system which would enable lawyers to communicate with each other by telegraph would be worth paying for. Confirmation of this idea was obtained from others, and the result was the establishment of a telegraph exchange. As the exchange was exclusively used by legal firms, the company was called the "Law Telegraph Company." Telegraph instruments were subsequently replaced by telephones, and the particular system adopted for working the exchange became known as the "Law" system.

Notwithstanding that this telegraph exchange was already in existence at the time of the invention of the telephone in 1876, it was not until January, 1878, that the first commercial telephone exchange was started. In the meantime, Bell's invention had been greatly improved, and shortly afterwards the introduction on a commercial scale of the Edison carbon transmitter and the Blake microphone placed telephony upon such a practical basis that its progress became assured. It was the microphonic era when was commenced that activity in telephone exchange work which necessitated attention being given to switching mechanism.

In addition to the public exchange system, every large telegraph office was the centre of numerous lines, which were connected together as required by means of a switchboard. An illustration of part of a well-known telegraph switchboard shown to the meeting consists of vertical and horizontal bars, the vertical bars being the lines, the horizontal bars providing the means of connecting any one vertical line with another by

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inserting plugs. The vertical lines terminate in springs resting on contacts. A telegraph instrument can be looped into circuit by a double-contact plug inserted between the spring and its contact. These springs were known to telegraphists as "spring-jacks." Those who started telephone exchanges, like all other founders of new industries, adopted in the first instance that which already existed, so far as it was within their knowledge, available for their purpose. All the first telephone switchboards have been traced by competent hands to a telegraphic origin. Hence the origin of the telephone switchboard is the telegraph switchboard, with the addition of indicators already in use for signalling purposes.

It will be remembered that telephone exchange business was started almost simultaneously in London by two different organisations—the Bell and the Edison Companies. The Edison Company had an experimental exchange at 6, Lombard-street. It was publicly opened on September 4, 1879, with 10 subscribers connected. The switchboard then used formed the subject of the first specification for a telephone switchboard in the English Patent Office (No. 3,794, September 20, 1879). The switchboard used by the Bell Company in their first exchange at 36, Coleman-street was of a different character. It is a rather curious circumstances that the two drawings of these, in addition to showing the first switchboards used simultaneously in English telephone exchanges, are also examples of two types of board—viz., plugboards and c ordboards—of which there were several varieties. The "Edison board"—as it is called here, because it was used by the Edison Company—is the upper part of the telegraph switchboard. The vertical strips are continuations of subscribers' lines; the horizontal strips are normally insulated from the vertical strips: but any vertical strip may be placed in electrical contact with any horizontal strip by placing a metal plug in the whole which is drilled at the point of intersection. Another metal plug similarly applied will place the same horizontal line into electrical connection with any other vertical line. Thus two subscribers' lines are connected together by means of a cross-bar and two metal plugs. There are no flexible cords whatever; even the speaking instrument is connected to a rigid bar. A different method is followed in the board used by the Bell Company, and consequently called here the "Bell board." The cross-bars remain, but the vertical bars are dispensed with. The subscribers' lines end in a spring-jack like the lower part of the telegraph switchboard, connections being made by means of flexible conducting cords having suitable plugs at each extremity. The one, therefore, is a plugboard, the other a cordboard; and for a while these two types provided the necessary material for the holding of opposite views amongst practical telephonists. The plugboard was preferred because it was free from the liability of broken cords, had its construction and circuits readily traceable, and also perhaps because it was generally more in accordance with previous practice in switches. The cordboard, however, had greater flexibility and possibilities of concentration.

Numerous varieties of plugboard were made, differing considerably in appearance, but having exactly the same method of working. It is not possible for me, in the time at my disposal, to describe in detail the various differences. It will suffice to say that the general idea was the same. The differences were either in construction or in the method of connecting the vertical with the horizontal bars. In some the plugs were loose, as in the one shown; in others—as in those originally used, I believe, in Manchester and Sheffield—the connecting plugs slid over a rod with notches for each horizontal bar, and were held in place by a spring clip fitting into the notch. These are differences of detail, and need not now be considered. It is of more importance to trace the methods of operation.

In the Edison board, whilst the majority of horizontal bars are free for use as connecting strips, two of them are appropriated for specific purposes. The seventh bar is connected to the operator's telephone, the twelfth bar to the earth. In order that each subscriber's line may be complete, so that the exchange may be called, the plug must be normally in contact with the earth bar. Where the fall of the indicator shutter shows that a subscriber is calling, the plug has to be taken out of the earth bar and set into the instrument bar. When the number of the subscriber required has been ascertained, the peg has to be again removed from the seventh, or instrument, bar and set into one of the other horizontal bars which may be unoccupied. The peg of the called subscriber is also removed from the earth bar and placed in contact with the horizontal bar already selected. The two subscribers' lines are then connected. No provision being made for ringing from the exchange, one subscriber calls the other. This act throws down both indicators, which the operator must replace.

In the Bell board the work is divided between two operators. One does the switching, the other the talking with the subscriber. The switching operator connects the subscriber with the table of the talking operator, who, upon learning the number required, instructs the switching operator to make the necessary connections, which he does with the flexible cords. Without detailing the various movements, it will suffice to draw attention to one point. The subscriber's line comes to a spring, and the spring rests on a contact. The contact is the earth. The plug with which connection is made removes the line from the earth, and that is one step in advance of the Edison board. A line needed to be broken and diverted. These requirements were separately met in the Edison board, whilst in the other case they were combined. In the development of telephone switchboards that is equivalent to making two blades of grass grow where one grew before.

The cordboard offered facilities in this direction which the pegboard did not. According to the Telephone Convention Report for 1883 (p. 33), plugboards were the most popular in 1881; there being amongst the companies reporting to the association 11,904 subscribers on plugboards, and 8,893 subscribers on cordboards. By 1882 the conditions were changed, cordboards having 16,799 subscribers and plugboards 12,755. By 1883 the change was shown to have some substantial foundation, the figures being 21,432 for cordboards and 12,763 for plugboards. These figures do not refer to the identical boards illustrated to the meeting, but to all varieties of their respective types. They show that the intervening period was sufficiently active and exacting to have had some influence in deciding which was the fittest type of board for survival. That type was the cordboard, and it may be desirable now to trace briefly the development of the most generally used form of cordboard for small exchanges.

For this purpose it is necessary to call your attention to a patent specification which I think may be called a classic in this branch of invention. It is dated November 29, 1879, numbered 4,903, and granted to C. E. Scribner. In the "universal jack-knife switch" there are the indicators and the individual connecting springs for the lines as in the Bell board, but arranged in distinct groups, and there are the horizontal connecting bars also. Although there are these points of similarity, there are improvements over each. In the Bell board the line comes to the indicator first, then through the spring-jack to earth. Inserting a plug into the spring-jack cuts off the earth, but the indicator remains in circuit. Scribner cuts off both drop and earth in one operation by the simple device of putting the drop the earth side of the jack, so that both subscribers' indicators are cut out of circuit instead of both remaining in. This is another step forward. The horizontal connecting strip is also improved by being turned round when engaged.

In connecting the two subscribers' lines together, two cords were used, as in the Bell board, each cord having a plug at either end, and the calling subscriber's line was connected to the revolving bar by one cord, and the same revolving bar connected to the called subscriber's line by the other cord. But, as both subscribers' indicators were cut out, some provision must be made for the reception of a disconnection signal. This switchboard brings us one more step forward in the inclusion of signalling apparatus in the connecting cords or bars at the central office, and I would invite particular attention to the way this was done, because I think that it has been overlooked by some writers on telephone subjects. To each bar an idicator was connected in derivation, one end of the coil being connected to the bar, and the other to earth. The specification says: "The earth connection of the coupling bar being through the coils of a magnet in no way interferes with the telephonic conversation"; which remark you will apply to the lines then prevalent with the electromagnet then used. The clearing-out drop was not mounted on the switchboard—there was a relay operating an audible signal; but a complete indicator is allowed for in the description. Although a clearing-out drop was connected to the central office circuit, the operator's telephone was still at the extremity of a separate cord, and needed to be plugged into or out of a spring-jack in order to be brought into or out of the subscriber's line circuit.

The circuit made up by the operator for the purpose of joining two subscribers' lines consisted of two cords and a bar. There were the operations of putting two plugs into spring-jacks and two plugs into a bar. If the two cords were permanently attached to the bar, a part of the work would be saved. If, further, the operator's telephone were to be switched into or out of the line by a key, the operations required would be more quickly performed.

The rapidly-increasing numbers in the exchanges rendered the bar system impracticable, whether of the fixed or revolving pattern. The bar therefore was discarded; the cords were lengthened, joined together, and the circuits so arranged that the ringing battery or generator, the operator's telephone, or the clearing-out drop, could be brought into use as required by the easy manipulation of keys placed in the most suitable position. This stage was reached in the switchboard now generally known as the standard switchboard. Its development dates from 1879, the germ being found in the universal jack-knife switch. The keyboard was an entirely new feature in switchboards, and was the logical result of the combination of connecting cords and plugs with clearing-out drops. The arrangement of the parts was strictly decimal—an obvious advantage hitherto neglected. Some of the keyboard circuits,

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being also applicable to multiple boards, were patented here, such as in specification No. 3,116, 1883, whereby the operator's telephone is in circuit immediately a plug is inserted in a jack. This is inserted by means of the other plug of the pair resting on a plate to which the telephone is connected, and accounts for the metallic heel-piece to the plug which then came into use. This board has been greatly altered in the parts of which it is composed, but in general arrangement and in the methods of operation very little, if any, improvement has been found possible, and for small exchanges it has been extensively adopted, or imitated substantially in its original form. Sufficient thought had been bestowed upon it to enable it to assume a form based on sound principles. The board was upright, with a shelf for keys and plugs. What was needed to be seen or handled was placed in the front of the board, but nothing else. All the connecting wires were placed at the back of the board, so that they could be attended to by the mechanic without interrupting the operator. The importance of this arrangement is very apparent now.

The introduction of the standard board probably accounts for the figures which I have already referred to as indicating the change in general estimation of plug and cord boards. Although the flexibility and concentration available with cords must have led to their general adoption, it is of interest to note how the placing of the operator's telephone into the cord circuit overcame one of the principal objections to cords. The existence of a broken cord must become known to the operator in the process of making a connection, and it could therefore be laid aside for another.

Whilst the standard board remains the most effective of what may be called "simple" switchboards—that is to say, those in which a subscriber has only one spring-jack or point of access to his line—it also forms in its constructive and keyboard arrangements the foundation for the more elaborate multiple board, which, although previously invented, soon borrowed the general disposition and the simple and practical mode of operation of the standard board.

The multiple board, as originally designed, employed the Scribner "jack-knife" switch, which was never used in England, I think. It consists of a metallic frame, with a blade pivoted at one end and resting on an insulated stud at the other. There are two holes. These are for plugs—one for the instrument plug, and the other for the connecting plug. The insertion of either plug will lift the blade from the stud, and so break the earth and indicator contact. The importance of space on the front of a switchboard led to a change in the jack-knife switch at an early date. Instead of lying lengthwise across the front of the board, the blade or spring followed more after the fashion of the spring in the Bell board—*i.e.*, having its length from the rear to the front, instead of from side to side. Though entirely different in appearance and construction, the modified switch was the equivalent of the jack-knife electrically. Whilst previous springs, as in the Bell board, were operated by flat plugs, the designer of the new spring-jack retained the round plug as used by Scribner, altering the shape so that it should be retained in position by the tension of the spring. This spring-jack and plug remain in their essential features the patterns now in use. The adoption of a round instead of a flat plug may seem a small matter, but it would require a very considerable amount of calculation to estimate the aggregate saving in time and money which has resulted therefrom.

It may be of interest to state that the inventor is Mr. J. C. Warner, one of the oldest of the expert staff of the Western Electric Company. Mr. Warner designed not only the jack, but also the indicator used on these switchboards. He brought to the design of telephone apparatus a wide experience, and you will probably agree with me that he graduated in a good school. Born in London in 1822, Mr. Warner became engaged in the manufacture of electrical apparatus in the workshop in which instruments were made for Cooke and Wheatstone. Subsequently he made some apparatus for experimental use by Morse on the line between Baltimore and Washington.

Having traced the simple switchboard to the stage in which it is supplied with an indicator and a spring-jack for each line, with pairs of plugs and connecting cords in whose circuit are placed convenient keys whereby the calling generator and the operator's speaking instruments can be quickly brought into circuit with either subscriber's line, consideration may be given to the more elaborate outfits required for large exchanges. It was on such a foundation that the multiple board was practically introduced, though it was designed at a much earlier period, and was being gradually matured.

For the purpose of illustrating the prior condition of affairs, I will recall attention to the Edison board, which, as I have mentioned, was installed in 1879. About the middle of 1880, the Edison Company amalgamated with the Bell Company. Some recommendations were then made for alterations in the switching arrangements. It was suggested that the operating should be divided between talking operators and switching operators, as in the Bell board, with the difference that the subscribers' lines should be continued to the talking table. Seventy-five lines were to be assigned to one talking operator, who was to be assisted by two others as switching operators. On the fall of an indicator the talking operator would depress the key pertaining to that line, would ascertain the number required, and then instruct the switching operator to make the required connections. If it should happen to be with a subscriber in another section—say, 200 in the third section—the switching operator would fix the peg in his own board, and then go to No. 3 board, fixing there the proper peg to connect No. 200 of that board with No. 1 of his own, using therefor the special connecting strips set apart for connecting each and every board individually with the other. It was asserted that "by this means an exchange can never become unwieldy." How soon that anticipation became falsified, only those concerned with the practical work of exchanges are able to appreciate. The method of connecting separate boards by special "strips," or bars, was very much improved by "transfer" systems as they were called when applied to standard boards; but by dire experience it became evident that the rapidly growing exchanges could not be satisfactorily or economically conducted when there was only one connecting point to a subscriber's line, and when communicating conductors had to be made up by sundry operators to enable a connection to be made.

I will show you an attempt to provide a remedy. It is recorded in a United States patent (No. 252,576), which was filed January 7, 1881, and from the wording of the specification I gather that the system was in actual use. The subscribers' lines passed through a number of boards (it was on the "Law" system, and easily done). The subscribers' numbers were inscribed on a signal-board placed in a central position. These numbers could be obscured by shutters. When a subscriber was put through, the operator would instruct the attendant at the signal-board to obstruct the number. On disconnecting, the reverse instructions would be given. Before connecting a line, the operator would look at the signal-board to see if the subscriber required were disengaged. This method was crude, but none the less deserves commendation as an attempt to overcome the difficulties which were becoming apparent. It is a multiple board without a test system. I cannot claim it as a link in the chain, because, as a matter of fact, the solution of the problem had already been in the Patent Office for over a year. It is in the specification to which I have already called attention—Scribner's, November, 1879. Numerous connecting points, without some prompt and certain means of indicating whether the line were engaged or disengaged, would be a remedy worse than the disease. A triangular conversation would be likely to produce more bad blood than a triangular duel. Now, in November, 1879, the exchange system in London had just commenced. It had certainly had a longer start, and assumed somewhat larger proportions, in the United States, but even there the necessity was not so great as to give rise to the idea which this invention conveys.

The idea is really twofold—firstly, to enable one operator, whilst answering the calls of a given number of subscribers, to connect them with any other subscriber in the exchange without requiring the aid of any other operator or making up any combination circuit; secondly, to inform the operator of the condition of the line with which connection was desired—whether engaged or disengaged. The first part of the idea was attained by increasing the number of spring-jacks indefinitely according to the number of operators required to carry on the work of the exchange. The second part of the idea is really the establishment of an information bureau in connection with every line, the bureau being supplied with information automatically, and giving up its information on demand. Three ways are shown for giving this information: one is a visual signal electro-pneumatically operated; another is the provision of double connecting blocks; the third forms the foundation of the multiple-test system as practically developed. In the diagram shown to the meeting only the local, or test, circuit is shown. The jack-knife switches illustrate two subscribers on three boards. When a plug is inserted in a jack (as is supposed to be the case in the first one illustrated), a spring, insulated from the blade, and connected with one pole of a battery, is brought into contact with a stud, which is connected by a line to similar studs on every other jack pertaining to the same subscriber. Over the studs are finger keys connected with the other pole of the battery. Depressing the key will close the local circuit and operate a bell or signalling instrument if the line is engaged, otherwise not. The information required was "engaged" or "disengaged." A local circuit partially closed at one jack would be completely closed by depressing the finger key at another jack of the same line: then the line was engaged. Depressing the finger key at one jack would not close the local circuit unless some other jack of the series had a plug inserted in it: then the line was not engaged. Here was no talking between operators, no passing of calls, or making up of lines. The information was obtained as the result of testing a local circuit, and hence the term "test circuit" as applied to multiple switchboards. I believe that the invention in the exact form shown in the 1879 specification was only used in one exchange; but it was the

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subject of continued experiment and study, and was being systematically developed so that it might be ready when required. At this stage it had a test circuit entirely distinct from the line, and a test key for each jack. We might reasonably expect that the development would be likely to take the form of simplification, and such was the case.

Before I relate briefly the line of that simplification, I would like to remind you that we are dealing with a comparatively early period of the telephone industry—not too early to appreciate the advantages of metallic circuit lines, as contemporary records show, but a time when the commercial side of the telephone exchange business practically settled the nature of the lines to be run, so that single lines were the rule. It is possible that some may be surprised to hear that metallic circuit multiple boards are provided for in Scribner's 1879 patent, the necessary modifications to the apparatus being clearly described so as to adapt them to metallic circuit use; the plan would not be considered satisfactory now, as only one side of the indicator is cut out. At any rate, switchboards were required to be developed for single lines, and this enabled a simplification to be proceeded with The separate test line gave way to a much more simple contrivance, which was communicated by C. E. Scribner, and patented here on June 22, 1883 (No. 3,116).

To illustrate this improvement I must again refer to the spring-jack already described in connection with standard switchboards. It consists of three parts—a frame, a spring, and a contact stud. As a standard board jack the spring is in metallic contact with the frame. To make this jack suitable for use on a multiple board it is only necessary to insulate the spring from the frame. Place a number of these jacks in a row, connect a subscriber's line with the spring of the first jack—the spring rests on the contact beneath—connect the contact with the spring on the first jack, and you thus have a line through the board which may be broken at any jack. This is the subscriber's line wire, which continues from section to section through the hammer and anvil contacts of the jacks, which contacts are mechanically sustained by the frame, though they are electrically distinct from it. If all the frames of a series of spring-jacks are connected together by another wire, you have two lines through the board—the subscriber's line and the test line. Insert a plug in any spring-jack and you break the main line, but connect together electrically the spring and the frame. In other words, the test line becomes a branch of the main line. The main line has an earth on it. Touch the frame of a jack (which is electrically a part of the test line) with a plug forming the extremity of a partial circuit, including a signalling instrument and a battery earthed at one pole, and it will be seen that you complete the test circuit if the line is engaged, and you don't complete it if the line is disengaged. The same result is attained as by the 1879 system, but by a much simpler arrangement of parts.

Another simplification was made in the apparatus for testing. The finger key contacts on each jack (1879) were so many branches from one side of a battery. Instead of having numerous branches, the same effect could be attained by having one movable branch. This was attained (1883), one separate test plug being provided for each operator. The test plug shown to the meeting is in the form of a thimble easy of application to the frame of a jack. The drawings show a bell, or buzzer, as a signal, but a "telephone" is suggested as an alternative, and it needed only a slight change to make a still further improvement by discarding the separate testing plug, making the operator's telephone the signalling instrument, and the connecting plug the testing medium. On touching the frame of a jack with the connecting plug the operator hears a click in her telephone if the line is already engaged. This method of testing by the operator arrived at the last-mentioned stage before the multiple board was put into practical operation in England, and so it remains to-day, although the electrical circuits are very different.

The early multiple-boards were very much like overgrown standard boards, the cords being below the keyboard. As then designed the cords were not long enough, and so in the Liverpool boards (the first used in England) the cords were overhead and longer.

After the Liverpool board, an important change was made in the introduction of what is variously called the "local section," or the "answering jacks." The latter terms seem preferable, since it corresponds so well to the answering plugs used with them. The Liverpool board was arranged for 200 subscribers to a section, the spring-jacks being of the Warner pattern, mounted on wood. The jacks being arranged in blocks of 100, placed in numerical order, it will be seen that, taking, for example, the first section, the 200 subscribers' jacks of that section were all at the operator's left-hand end of the board, and all three operators had to reach those two jack panels. This difficulty was met by adding yet another jack for each subscriber—the answering jack. These answering jacks were spread out along the board, so that the answering was more promptly done, and an operator had not to reach past another in responding to a call. This plan was first introduced in the multiple board shown at the Philadelphia Electrical Exhibition. There was a further modification in the design which has sometimes been called a "double-deck" arrangement. At the top of the board were the general jacks, then the clearing-out drops, then a shelf containing half the plugs—one of each pair—then the indicators, below them the answering jacks, then another shelf with the remaining plugs and the keys. This double keyboard arrangement has been retained, but the disadvantage attending the separation of the plugs became speedily apparent. Even so slight a change in the relationship of the plugs slowed down the operating, and their separation also involved a risk of using the wrong plug for completing a connection. The separation of the plugs was therefore abandoned. The plugs were both placed on the upper shelf, the clearing-out drops and the answering jacks changed places, and this arrangement of parts is still retained. The arrangement of indicators and jacks was rendered uniform in all sections—a great advantage in changing operators from one section to another.

Another problem was met in this 1884 board. Exchanges were growing larger and larger. More subscribers had to be provided for. More spring-jacks had to be placed on a section, the face of which could not be enlarged. The limitation of size in a multiple section is easily understood. It is the limit of reach of the outstretched arms. That is about 6ft. The height is a little more variable, as the reach in that direction does not interfere with other operators. If, therefore, it becomes necessary to put an increased number of units in a given area, it can only be done by reducing the size of the units. A reduction in size of parts was then made, and further reductions have since been made. So far as designs and patterns are concerned, the size has been reduced so as to attain a capacity beyond the requirements of any exchange under existing conditions.

With the reduction in size came a radical change in the method of construction. Instead of each jack being made separately and then mounted on a base, the base and the jacks were incorporated. Twenty jacks were made into a strip, which was a combination of metal springs and insulating material. This was simply a constructive change, carefully carried out so as to make no change in the method of operation; the same round plug being used, and the same bush, carefully shaped so as to make the act of testing easy and the completion of the connection quick. Although various changes in size and construction of parts were introduced after 1884, the general design and the circuits of the board were not materially altered for some years.

During these years the telephone exchange business had been very rapidly extending. Long-distance lines were being erected; overhead wires in some places were having such violent hands laid upon them that burial became necessary; the development of electric lighting and traction and the production of powerful currents disposed to extend unduly their sphere of influence—all these causes had their effect upon telephone switchboards. Metallic circuit service had to be provided for, and as the change must necessarily be gradual mixed service had to be given first. This requirement was met with a minimum of change in existing apparatus. The earth circuit multiple had in the test wire a line which could be made available as a metallic return by a slight change. The engaged test, as you will recollect, depended upon there being an earth connected to the test circuit. Put an earth on a metallic circuit line when engaged, leave it off when not engaged, and you have the necessary dual condition for negative or positive information. This earth was attached to one or both limbs of the cord circuit, and formed a part of the local circuit, which was completed by the plug in the act of testing. Between the earth and the cord is placed a retardation coil, which prevents currents of high frequency from either entering or leaving the telephone line, but is no bar to the simple battery current required for the test. This may be termed a transition board, but it is a very practicable one.

The importance of accurately balancing the talking lines, as well as the certainty of the test signal, showed the advisability of going back to the original 1879 plan of using a test circuit entirely distinct from the line circuit; and I think that this importance was insisted upon by none more strongly than English telephonists. But here a difficulty presented itself. Experience showed that as the jack contacts in a board increased, so did the troubles due to poor contacts between the line spring and its contact stud. Supposing a 4,000-line board of normal dimensions, on the single or mixed circuit system, there would be 21 jack contacts in the line. To adopt the system of cutting out the indicator with metallic returns, and to employ a separate test circuit as well, would require three contacts in each jack; so that a 2,000-line board of such a character would have 33 jack contacts, or about 50 per cent. more than a single or mixed circuit board of twice its number of subscribers.

With the general improvement in the quality of external lines, it is obvious that it would not do to put into the switchboards apparatus of such a design as would lead to defects in the very portion of the circuit under the electricians' immediate

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control. This consideration led to another new departure—the last to which I shall call attention—and that is the arrangement of the subscribers' lines in an unbroken circuit throughout the board, with no contacts whatever in the jacks, and the automatic restoration of the indicator. The branching of the line contacts and the use of bridging indicators in themselves are no new departure in switchboards. The Post Office use branched line contacts and bridging indicators. It is of interest also to note that their indicators need no manual restoration, but the means by which these results are accomplished are not available for the methods of exchange working generally adopted. New means had to be invented. The idea had been "in the air" for a considerable time, but, as usual, lacked the final touches to make it practicable, like the invention of the telephone itself. I will indicate one of the principal difficulties. Let us suppose that two subscribers are connected, say No. 1 and No. 3,000, the connection being made at No. 1 board. The indicator of No. 3,000 is at the other end of the room. On sending a clearing-out signal, both indicators would drop unless cut out, as in the older system, or prevented in some new way. One of the earliest attempts at meeting this requirement was in Scribner's English patent No. 20,099, December 9, 1890, which was one of the preliminary steps in the branching system so far as the jack contacts were concerned. The desirability of the separate line for test purposes, however, helped the solution. This test circuit might very well bear an additional burden. The application of a locking device on each indicator, and controlled by a battery in the test circuit, was the first stage. The locking was a necessity, but it is only natural that it should have led to the restoration of the shutter to its normal position, thus rendering another of the switchboard operations automatic. The first design for the circuit of this board was by Mr. Bell, one of the switchboard experts of the Western Electric Company. But, in addition to the Western electric staff, the design of the board was so fully discussed by the switchboard committee appointed by various telephone companies, that I am unable to give, as I should like to do, the individual credit for details.

The indicator spring-jack and plug are illustrated in the diagram. The indicator consists of two coils mounted on opposite sides of a plate. The longer coil is the operating coil, and it is connected in bridge across the line. The short coil is the restoring part, and is connected in the test circuit. The operating coil when energised attracts the armature, to which is attached the arm holding up the shutter. The shutter opens out if the test circuit is incomplete. But if the test circuit is completed by having a plug in any jack of its line the restoring coil is energised and the shutter prevented from opening. The spring-jack has three springs, a bush, and a testing ring. The short spring is the contact from one limb of the line, the bush the contact for the other limb. The two springs of even length are the contacts for the test circuit. The plug has three contact surfaces. The point engages with the short springs, the sleeve makes contact with the bush of the jack, and the ring between the sleeve and the tip connects together the two test springs, thus closing the test circuit and restoring the indicator. The advantage of this construction is that there are no make-and-break contacts in the jacks whatever, and in this switchboard we reach the highest development so far in combining the most perfect talking circuit, a mechanism free from the liability of previously-existing troubles, and at the same time a reduction in the manual work.

Comparing 1880 with 1894, it will be observed that in an exchange to which I have already referred, having about 300 subscribers, it was considered necessary to provide a minimum of one operator to 25 subscribers. In the latest London switchboard to which I have referred, fitted for over 3,000 subscribers, there is a maximum provision of one operator for 50 subscribers, and in other places on boards of the same system 100 subscribers are attended to by one operator. The number of operators to subscribers is entirely dependent on the load line of the exchange, and there will be necessarily great differences, according to the nature and number of the calls. It will therefore be seen that the development in switchboards has followed the general law of enabling more work to be done with less labour.

The latest switchboards fitted in London are on the branching system, and it is needless to say that they contain many features originated by those who have the responsibility of their fitting up and maintenance. I hope the omission of detailed information on these points and many others will not be construed as an absence of recognition of the value of the work done outside the limited number of persons to whom I have referred.

I have advisedly limited this outline sketch to a record of what has been accomplished in the line of switchboards whose merits are to some extent guaranteed by general recognition, and I have also advisedly omitted any reference to complex problems, such as trunking systems between separate exchanges. I do not propose to anticipate the result of experiments now in progress, or presume to speculate on the possibilities of the future, but I would like to be permitted to make one comparison of the present with the past. The progress of telephony has been the subject of some comment. There are differences in that progress—of course local circumstances and conditions will mostly account for them—but let us make a comparison without going away from home. Between the setting up of the first and the last telephone switchboards to which I have drawn attention, there has been an interval of 15 years. We are accustomed to regard 1837 as the date of the introduction of the electric telegraph, although, of course, active work in a commercial way had not then commenced. Fifteen years after 1837 there was no public telegraphic communication between London and Brighton. The charge for a message of about 100 words to Liverpool was £5. These charges were regarded as high. "But no doubt," says a contemporary record, "these will be diminished when the company's arrangements get more matured, and they are better able to transact any amount of business which may be offered to them. The directors appear to be acting on the policy of checking, rather than encouraging, the use of the telegraph by the public until their establishments are everywhere in perfect working order." Now the most maligned telephone companies have never, I think, been accused of turning away customers. Notwithstanding the novelty of their business, they have been able to invite additions instead of requesting withdrawals. That undoubtedly was largely due to the extent to which the telegraph had prepared the way. Men experienced in the laying of lines and the management of instruments were already obtainable; but there is one direction in which there had been no previous experience of any moment, and that is in the methods and mechanism of intercommunication. The invention of the telephone was defined by judicial authorities as the creation of a new art. The greatest utility of that new art has been found in the development of that means of intercommunication, the exchange system, and the most important feature in the exchange is the switchboard. It has been a very easy task for me to pick out landmarks and put them together to show the route which was probably traversed; but members of this Institution are too familiar with such matters to need reminding that it was by no means so easy a task to devise and manufacture, or set up and maintain in working order, intricate apparatus, which should keep ahead of the ever-growing public demand for telephonic communication. I think, however, there can be no doubt that but for the invention and adoption of the multiple switchboard there would be some parallel between telephonic communication now and telegraphic communication at the date I have mentioned; its progress would have been checked by the impossibility of doing the work required.

Discussion.

The President, in proposing a vote of thanks to the author, said that the latter had come forward at a time when they had greatly needed communications on this subject.

The vote of thanks was then cordially passed.

Mr. Langdon, the well-known telegraph engineer, was indebted to the author for the interesting paper. He was very unacquainted with telephony, and the switchboards used on the railways were very simple.

Mr. Phillips, after paying a tribute to the author, remarked that the "Edison" board had been much improved from that referred to by the writer of the paper. He thought the amount of labour on the part of the operator was less in the case of the "Edison" board than in that of the Bell. The multiple board was a great feature, which had enabled numbers of subscribers to be dealt with. He then referred to a multiple board devised by Mr. Hoare and erected in Chancery-lane two years before that in Liverpool. The branch system, which was introduced in August last, had been a great success.

Mr. Hoare, who handed in photos of the historical board mentioned, explained the reasons for the design of the board, which had since that time been altered.

Mr. Calder having made a few remarks in reference to his experience in telephony,

Mr. Addenbrooke, who had endeavoured to design switchboards, stated that English telephonists were handicapped in comparison with their American brethren. As an instance he mentioned that an American company, in touch with all the telephone companies, had an invention department, where ideas and details were worked out to the general benefit. The author, he thought, had not sufficiently brought out the simplicity and perfection of the multiple board. The paper would form the basis of an enormous mass of interesting material, and he suggested that the testing departments, exchange systems, etc., should form the subjects of future papers.

Other speakers having addressed the meeting, the author replied and the proceedings terminated.

City Company's Engineer.—Mr. Frank Bailey has been appointed engineer to the City of London Electric Lighting Company, Limited, and Mr. J. Cecil Bull, the secretary, has taken over, as well, the duties of commercial manager. Mr. Frank Bailey will retain his position as engineer to the Metropolitan Electric Light Company.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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ANTI-SMOKE.

Schemes and projects for the suppression—partial or complete—of the smoke nuisance we shall perennially have with us, just as with the big gooseberry and "marriage a failure" topics, affording unlimited scope for everybody to speak freely, confidently, and (in many cases) ignorantly. Laws have been promulgated and passed for the purpose of putting an end to the pollution of the atmosphere by carbon compounds; innumerable sums of forty shillings and costs have been forfeited to the majesty of law; commissions have sat and inventors pondered, yet things are very much as before, though, unfortunately, we cannot say that "nobody seems one penny the worse." Finally, a complete range of trials and tests instituted by the Prussian authorities proves with tolerable clearness that all these efforts lead to extremely negative results, and will probably continue to do so.

True, the enquiry last mentioned—which has just been summarised in a report—appears to have dealt with what we may call "industrial" smoke, rather than smoke in general; but in manufacturing centres, at least, it is usually the case that the large chimney stacks are at fault. In residential towns, and notably in London itself, the mere numbers of domestic chimneys, each contributing a small quantity of absolutely foul smoke, effect quite as great an annoyance as ironwork stacks or chemical fume chimneys. The report of the Prussian enquiry states that in not a single instance of all the tests made with all the latest and most improved devices and methods, was it possible to obtain complete combustion without smoke—an exceedingly sage but trite conclusion, for it is what we all knew long ago.

One might discuss before an audience of engineers the questions of grate surface, chimney draught, fuel, design of boiler or furnace—whatever the purpose desired—but the actual and immediate end to be aimed at is not so much the greater consumption (or, which is the same thing, the less production) of foul smoke in a hundred thousand furnaces, as the reduction of the number of such furnaces. Suppose, for instance, that an average amount, s, of smoke is produced from n furnaces, then the total amount is $n\,s$. If we could effect a reduction of 25 per cent. in the number of furnaces, and also secure a saving of 5 per cent. in the smoke output by improved appliances (mechanical stokers, rocker bar grates, better calculated air admission, etc.), instead of $n\,s$ smoke, we should have a double economy leading to a result somewhere about ·71 of that amount, whereas the saving due to improved appliances alone (without reducing the actual number of furnaces) would merely give a result equal to about ·92.

It is, however, useless to enter into calculations of this type without going a little further and showing how such a saving is conceivably to be effected. In the first place, very much of the wanton waste and annoyance of smoke in the industrial districts must be ascribed to the fact that each individual works has its own source of power—its own engines, boilers, and chimneys. Obviously the great variation

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in output required, and the splitting up of generating plants into small scattered units in this way, must lead to continuous bad working of the power source—bad, that is, in the sense of being uneconomical. It is so by reason, first, of the varying demand, and, second, of the smallness of the unit. If any serious effort is to be made in the direction of suppressing the smoke nuisance, it must lie in the concentration of power for industrial requirements. This does not mean by any means the concentration of works or of workers, but merely of the power-developing plants.

How else can this be accomplished better than by the employment of electric energy? Distance from source to point of application matters little for such a service, and hence a centralisation of power is at once not only feasible, but economical. There is at present, we regret to say, hardly a single large factory or works where at least two or more engines or like sources of power may not be found, the number practically increasing with the area occupied by the works, in order to save the waste and expense of countershafting or other connecting gear. These prime movers cannot possibly have the same careful and economical attention or operation as much larger units assembled together in one large central supply station designed for the special purpose with every conceivable improvement for preventing smoke and other waste.

The same can be said with reference to the second great source of air pollution—the domestic or house fire. We are all familiar with the excessive wastefulness of the open firegrate, sending out merely a small percentage of its heat energy into the room, yet so beloved of the English heart for its ruddy glow and cheerful aspect. There is, however, probably even a greater chance for improvement here than in the industrial furnace. The fair sex is proverbially—or naturally, let us say—inclined to comfort and cleanliness; and when the advantages of electric cooking and heating have been a little more widely diffused by their present champions (to whom every single person interested in electrical matters may well wish success), half the battle will be won—and let us hope, also, that half the house chimneys will find their occupations of taking fire or bringing down smoke gone for ever, and that this nuisance will be mitigated, if not entirely removed.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

EXPLOSIONS AND HOW TO PREVENT THEM.

SIR,—As I was the first in London to lay electric light cables underground for the use of business establishments, my experiences with explosions and the simple means adopted to stop them may be of service.

Our first explosion occurred in the year 1882, in the Brixton-road, near the Bon Marché, and as there were then no Board of Trade enquiries on electric lighting the matter dropped; but when we had a second, and shortly afterwards a third explosion, something definite had to be done to stop any further chance of accident. I was then convinced that the explosions arose principally from want of proper ventilation in the porcelain pipes through which the electric light wires were laid, and I adopted the simple plan of ordering the lids of each trap to be lifted for a few minutes every morning, but finding daily attention troublesome, we perforated a few of the covers with a drill, and after this was done the explosions ceased.

In all cases where electric light mains are laid in underground conduits the ventilation ought to be good, and means provided for accumulations of water to gravitate into the sewers. Where communications with the sewers are not allowed, "sump" holes or tanks ought to be sunk to receive the water, which could be pumped out at intervals. If these precautions were intelligently adopted London would in future be free from explosions, which are caused principally through imperfect ventilation. The sparking is no doubt produced by the heavy traffic of the streets causing the electric light wires, connected with screws in the boxes, to vibrate.—Yours, etc.,

A. L. FYFE.

Electric-avenue, S.W., January 22, 1895.

COUPLING FOR RAILWAY BRAKES.

SIR,—Could you tell me whether there is any reliable coupling for electric railway brakes. If so, in what number shall I find it? What has become of the Electric Traction Company? Have they been wound up or amalgamated?—Yours, etc.,

A. M. BUSHELL.

London, January 19, 1895.

REVIEWS.

The Indicator and its Practical Working. By A. G. BROWN. Manchester and London: The Globe Engineering Company, Limited.

This is a new edition of a well-known book dealing, of course, more particularly with the indicator and other steam-using appliances manufactured by the author's firm. We do not obviously attempt to criticise the qualities or standing of these devices, as compared with those of other makers, but can unhesitatingly speak of the book itself as being a most valuable work for all engineers and steam users. It not only contains a mass of useful tables and formulæ connected with steam-engine economy, but also may be characterised as a scientific treatise on the theory and proper employment of the indicator in general. The diagrams alone are worth study by all who have to deal with steam-engines, for they represent something more than scholastic tests on motors of antique form, being taken from the most modern types of engines in regular service. We again recommend the book to all interested in steam raising and use.

THE DESIGN AND EFFICIENCY OF PLANT FOR THE TRANSMISSION OF POWER BY ELECTRICITY.

BY W. C. MOUNTAIN.

(Concluded from page 68.)

Having considered the loss in cables and in transmitting power from a steam-engine of small size, but of a fairly efficient type, over a distance of 440 yards, it becomes necessary to consider, comparing this system with steam power, what the loss would be, assuming steam had been used. Referring to the losses due to the condensation of steam in long pipes, attention may be drawn to some tests carried out by Mr. Hy. Davey, M.I.C.E., on a 7½in. diameter steam-pipe, 1in. thick and 1,100ft. long, conveying steam at a pressure of 45lb. per square inch to an underground pumping engine in the Morton pit at Clay Cross, the pipes being covered with a non-conducting cement. As the result of careful observation, it was found that the condensation of steam in the pipe amounted to 500lb. per hour when the engine was standing, and 750lb. per hour when the engine was working, equivalent to ·183lb. and ·274lb. per square foot of surface of pipe per hour respectively.

In another experiment, carried out by Mr. W. Worby Beaumont, M.I.C.E., at the Staveley Hill Collieries, it was found that in a total length of 2,300ft., 1,900ft. of which

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was underground, and covered in some instances to a depth of 2ft. with rough stuff, left after cutting away the coal, the condensation in a 6½in. pipe, 1½in. thick, conveying steam at an average pressure of 34lb. per square inch, was 600lb. per hour with the engine standing, and 1,400lb. per hour with the engine at work, equivalent respectively to a condensation of ·113lb. and ·265lb. per square foot of surface of pipe per hour.

In dealing with the losses under the second head—viz., those due to the inefficient working of the engine at low loads—it will probably be sufficient for the present purpose to briefly consider the conditions under which such engines work. In most instances the engine has been originally put down of an ample size for the maximum power likely to be required from it, while the average power is in the majority of cases probably 25 to 50 per cent. of the maximum power likely to be required from it, while the average power is in the majority of cases probably 25 to 50 per cent. of the maximum. Working under these conditions, especially with non-condensing engines, it is not surprising that the results obtained are very uneconomical. Perhaps the most striking instance of the wastefulness of this method of working is to be found in the following tests, carried out on some small workshop engines at Birmingham :

Nominal horse-power.	Probable i.h.p. at full load.	Average actual i.h.p. per hour during test.	Coal consumption in lbs. per i.h.p. per hour during test.
4	—	2·96	36
15	45	7·37	21·25
20	60	8·20	22·61
15	45	8·60	18·13
25	75	23·64	11·86
20	60	19 08	9·53
20	60	20·	8·50

These figures are interesting, as they actually represent the loss in steam-pipes which have been well covered, and upon engines of a size generally found in workshops.

In our president's very valuable address, which has, to a great extent, completely cut the ground from under the writer's feet, he has brought forward some most valuable information respecting the consumption of steam in engines in his own works, and on reference to his figures it will be seen that they correspond very nearly with the efficiency of the small engines which the writer gives above. The writer has further prepared an estimate of the approximate cost of (1) a complete steam-power plant, consisting of boilers, steam-pipes, and 10 horizontal engines each of 25 effective horse-power : (2) an electric plant, consisting of a high-class compound steam-engine, with boiler, dynamo, conducting cables, and 10 25-h.p. electric motors :

No. 1.—*Steam-Power Plant.*

Four boilers 30ft. long by 7ft. diameter, complete with fittings and mountings	£1,400
Foundations for four boilers	500
Ten horizontal steam-engines, each of 35 i.h.p., or, say, 25 effective horse-power, each £160	1,600
Main steam-pipes connecting the four boilers together, with branch steam-pipes for the 10 engines, at £60 each	600
Erecting four boilers, 10 engines, and 10 lengths of piping	500
Foundations for 10 engines, at £20 each	200
Total	£4,800

No. 2.—*Electric Plant.*

Two Lancashire boilers, each 30ft. long by 7ft. diameter, for a working pressure of 120lb. per square inch, complete with fittings and mountings	£700
One compound horizontal condensing steam-engine of 400 i.h.p.	950
Foundations for engine, boilers, dynamos, etc., exclusive of chimney	300
One dynamo, output, say, 225 units	1,000
Driving ropes	50
Main switchboard, with measuring instruments	100
Ten electric motors, each of 25 effective horse-power, at £140	1,400
Cables for 10 electric motors, say, £20 each	200
Foundations for 10 motors, say, £5 each	50
Erection of plant, say	250
Total	£5,000

From the above it will be seen that the first cost of the steam plant may be slightly less than the electrical plant, but it will be necessary now to turn to the cost of working, and two approximate estimates are given—No. 1, of the approximate cost per annum of 3,000 hours for maintaining the steam plant; No. 2, the approximate cost per annum for maintaining the electrical plant. This calculation is based on the assumption that the 10 small engines will each consume 40lb. of steam per indicated horse-power per hour, or, say, 56lb. per effective horse-power, and to this an allowance of 20 per cent. has to be added for condensation in steam-pipes, making the total consumption of steam equal to 68lb. The evaporative efficiency of the boiler is taken at 6lb. of water per 1lb. of coal, which the writer considers a very ample allowance for the class of coal which is used in most engine works. Therefore the consumption of coal per effective horse-power will be, say, 11lb. per hour. In the electrical plant, the coal consumption is based on the assumption that the engines will require 15lb. of steam per indicated horse-power per hour, and the indicated horse-power of the engine is taken at 400. The evaporative efficiency of the boiler is taken at 6lb. of water per pound of coal, which will be, say, 2½lb. of coal per indicated horse-power per hour.

Steam Plant.

Coal consumption for 10 engines, each giving 25 effective horse-power, or, say, 350 i.h.p.—*i.e.*, collectively 350 h p.—at 68lb. of steam per effective horse-power, including condensation in steam-pipes at 11lb. of coal per effective horse-power per 3,000 hours, working per annum = 3,683 tons, at 6s. per ton	£1,104	14	0
Labour—three stokers and four men to look after the four engines—total, seven men at 30s. per week, £10. 10s. per week for 52 weeks	546	0	0
Water for boilers—7,140,000 gallons, at 6d. per 1,000 gallons	178	10	0
Oil for 10 engines, at 7s. 6d. per week	195	0	0
5 per cent. interest on capital outlay, £4,800	240	0	0
5 per cent. depreciation on capital outlay, £4,800	240	0	0
The total cost, therefore, comes to	£2,504	14	0

Electrical Plant.

Coal consumption for 400 i.h.p at 15lb. of steam per indicated horse-power per hour for 3,000 hours at 2½lb. of coal per indicated horse-power per hour = 1,334 tons at 6s. per ton	£400	4	0
Labour—one stoker, one engineman, and one man to attend to electric motors, at 30s. per week ; £4. 10s. per week for 52 weeks	234	0	0
Water for 1,800,000 gallons, at 6d. per 1,000 gallons	45	0	0
Oil for engine and 10 motors, at 30s. per week	78	0	0
5 per cent. interest on capital outlay, £5,000	250	0	0
5 per cent. depreciation on capital outlay, £5,000	250	0	0
The total cost is therefore	£1,257	0	0

From the above it will be noted that the actual saving in favour of the electrical plant will be £1,247. 4s. per annum, so that the total cost of the plant would be saved in, say, four years compared with a steam plant, which would cost practically as much money to erect. The above figures show that an effective horse-power by a steam plant can be obtained for £10 per annum. An effective horse-power by electricity can be obtained for £5 per annum. The writer trusts that the above estimates, which are, of course, more or less approximate, will be criticised by the members present.

A practical example of the efficiency and saving of an electrical plant over a steam plant is obtained from the writer's own experience in his firm's works in Newcastle. Prior to the adoption of electric motors the works were driven by a Cornish boiler 25ft. long by 6ft. diameter, 60lb. working pressure, a semi-portable engine of 50 effective horse-power, and a vertical boiler of 20 h.p. The Cornish and vertical boilers steamed the engine in the machine shop, and also supplied steam to the engine in the erecting-shop for testing dynamos, the semi-portable engine being used for driving the erecting shop and pattern shop. As this plant occupied very valuable space, the writer's works being in Newcastle, where rents are very high, it was decided to take out this plant, and to put down a plant consisting of two locomotive boilers of 160 h.p. collectively, 160lb. working pressure ; one vertical compound steam-engine, with cylinders 9 by 18 by 10, giving approximately 100 i.h.p.; one dynamo to give an output of about 40,000 watts. This plant now drives electric motors in the pattern shop, erecting shop, foundry, and a number of small motors in the tool shop, etc., with the result that by the removal of the old steam plant from

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the centre of the works a new shop has been erected, 90ft. long by 45ft. wide, two men have been dispensed with for attending to the engines and boilers, and the coal consumption has been reduced from 25 tons per week to about 12 tons per week, and it cannot be estimated that the annual saving is less than £700.

Class of Motor.

In laying down an electric transmission plant it is necessary to consider the class of motor most suited for the

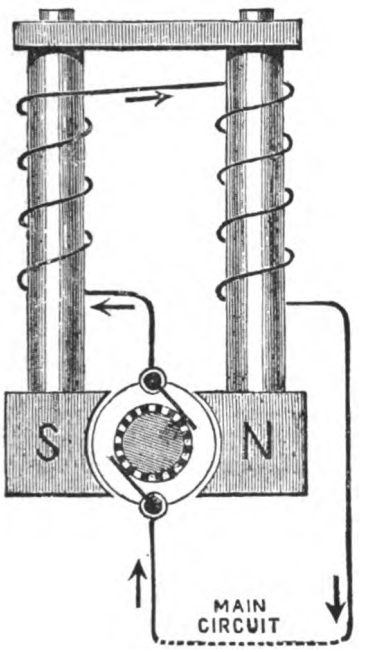

Diagram No. 4.

particular work that it is required to drive. Diagram No. 4 represents the winding of the magnets of a series-wound motor. Diagram No. 5 represents the windings of a shunt-wound motor. Diagram No. 6 represents the windings of a compound motor.

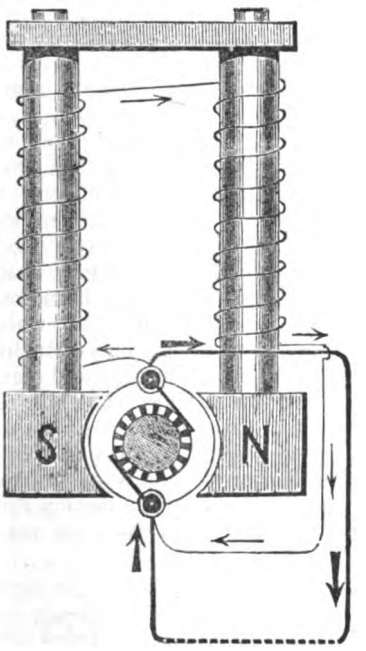

Diagram No. 5.

The series wound motor is used in positions where great starting power is required, such as for cranes, haulage gears in collieries, and for single motors for driving pumps and heavy machinery where the load is constant after being once applied. This motor, however, does not give a constant speed, and is therefore unsuited for machinery where the load is variable and the speed required to be constant. A shunt-wound motor has not the same starting power, or the advantage of running at a practically constant speed under any conditions of load, and is therefore particularly suitable for driving light machinery where it is necessary to maintain an absolutely constant speed under varying loads.

A compound-wound motor (which is a machine very seldom made) is a combination of a series and a shunt machine, and whilst it has not the perfect regulation of speed that can be obtained from a shunt motor, it has the advantage that by the addition of a series coil considerable starting power can be obtained. This type of motor the writer has fitted on to cranes, where the motor is allowed to run constantly with great success.

Reduction Gear.

As a motor generally runs at a speed considerably in excess of the speed of the machine which it is intended to drive, it is necessary to reduce the speed by one or other of the following methods: (1) Worm gear.—The writer has supplied worm gear to electrical power plants with very great success, but if this gear has to run properly it must be very accurately made, and it is desirable that the worm should be at least double threaded, if possible treble threaded. A satisfactory material for the worm and worm wheel is case-hardened wrought iron for the worm, and phosphor-bronze for the worm wheel. (2) A very ingenious,

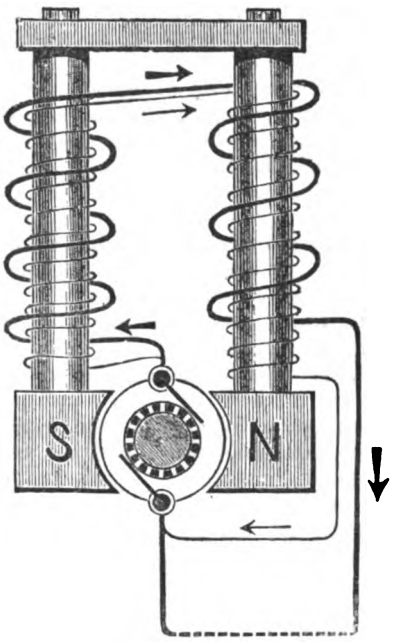

Diagram No. 6.

and at the same time compact and economical, type of reduction gear is the Humpage and Jacques, as shown. This gear, it will be noted, consists of bevel wheels placed in a box. The box can be filled with oil or other lubricating material, and the whole gear occupies very little space.

A third method is a reduction entirely by spur gearing. This method of driving is usually very objectionable, because it is almost impossible to prevent considerable jar upon the wheels owing to their high speed, with the result that it is not an unusual thing to see the wheels strip, and a vibration is set up in the armature of the motor which is almost certain to cause damage sooner or later.

A fourth system is a combination of belt driving and spur driving, the belt being placed between the motor and the countershaft of the machine. The belt acts as an elastic medium between the motor and the gear, it takes all vibration off the motor, and works extremely satisfactory.

A fifth system is entirely by belts, and probably for general work, particularly in engine works, this type of gear will find most favour.

It is, however, absolutely necessary to consider in laying down any works where motors are to be used, particularly for individual machines, that a more or less considerable loss exists in the reduction gear necessary between the motor and the machine, and it is not safe as a general

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practice to allow less than, say, 15 to 25 per cent. for this loss.

The writer trusts that the remarks he has made, together with the comparative estimates and general information in the paper, will be of value to the members, and regrets having taken so much time.

A NEW MINING MOTOR.*

BY HENRY A. MAVOR.

The ever-increasing size and depth of mines, as minerals are worked out of the more easily accessible fields, call for the application of power at ever-increasing distances from the points where power can be conveniently generated. The use of mechanical power for the operations of ventilation, hauling, pumping, and coal cutting is gradually increasing, while the conditions of work in the mines are becoming such as to render the use of the older methods of power transmission increasingly difficult. Transmissions of power by steam, air, water, or ropes, all present increasing difficulty as the distances are increased, so that the attention of mining engineers is now strongly directed towards the possibilities of power transmission by electricity.

The wise conservatism which prefers to proceed upon the lines of the old and painfully acquired experience is from time to time broadening its base and including in its grasp another weapon with which to grapple with new or increased difficulty.

The beautiful simplicity of electrical apparatus goes far to compensate for the disadvantages introduced by the application to the mine of another style of plant to which the miners have to become accustomed, and the great efficiency under suitable circumstances of electric plant more than compensates for the losses incidental to the transformation of energy from one form to another. It is not be supposed, however, that the electrical engineer pleads for his methods of power transmission a universal advantage over all the established methods. In most cases it will be found that for simple transmission, up to about half a mile from the source of power, the older methods will be less costly and as efficient for moderate powers. The losses due to transformation of mechanical to electrical energy, and the retransformation to mechanical energy, bear too large a proportion in such cases to the loss in transmission to admit of a favourable comparison with any method where the energy is directly transmitted without transformation. For longer distances electricity shows a rapidly increasing advantage in first cost and in efficiency, and also in the important element of convenience. Electric cables and electric motors are the most compact and portable means for conveying and using power underground, and in such operations as coal cutting and dock pumping, the ease with which the power may be made to follow the work is of enormous advantage.

These general questions have, however, been pretty fully gone into in Mr. Scott's paper, read before the institution in 1891, and in the discussion on that paper, and need not more be enlarged upon.

The conditions of coal mining specially require that any machinery used in the mine must conform to certain conditions, all of which may be met by an electric motor constructed specially for mining purposes. The first essential is certainty of working. The motor must not break down; it must be light and easily handled; it or its parts must be of such a size that they can be conveniently passed down the shaft and along the roads; it must be efficient; and, lastly, it must be as cheap as possible, consistently with these other requirements. Power plant underground is usually vitally connected with the working of the mine. If the pump, fan, or hauling rope stops, the least possible result is serious and prolonged inconvenience. Now, the state of matters in a coal mine is not such as is most conducive to the welfare of electrical apparatus. The temperature is high, dust and damp are in the air, and the engineers are accustomed with ponderous slow-running plant requiring little attention. The motor must therefore not only be well constructed mechanically and electrically, but it must be suited for working under conditions to which in ordinary circumstances electric plant is not subjected.

Considerations of economy and efficiency tend to the use of as high an electric pressure as possible, but for the generality of coal-mining work in this district, an E.M.F. of 500 volts is found to be sufficiently high. The insulation of armatures for this pressure is comparatively simple, but great care has to be taken in all dynamo machines that they are of sound mechanical structure. This presents some considerable difficulty, because the electrical and magnetic requirements are not on the whole consistent with the mechanical conditions.

As is well known to most hearers of this paper, the action of the electrical motor depends on the force exerted between what is called a magnetic field and conductors carrying an electrical current. To attempt to explain this action to engineers who have not given any study to the question generally leads to failure and mutual recrimination. Undeterred by the experience of others, I make another attempt, in the hope that it may be possible to convey some idea of the mode of action as it presents itself to the mind of the electrical engineer.

Although it has to be admitted that the whole matter is still in the region of speculation and hypothesis, it must also be borne in mind that many of the operations in nature are involved in much deeper mystery. The bases of the phenomena of life are hidden in still impenetrable obscurity, and the cause of such a familiar phenomenon as that of gravitation is so far from being understood that Lord Kelvin wrote of it only last year: "Absolutely nothing has been done either by experiment or observation towards deciding between Newton and Bernouilli as to the question of its propagation through a medium, and up to the present time we have no light even so much as to point a way for investigation in that direction."

Strangely enough, the much more recently observed phenomena of electromagnetism have led to the development of theories which have all the appearance of consistency with the observed phenomena. Without entering into any elaborated quotation of authorities, I will give you what appears to be the most approved way of looking at the phenomena with which we are concerned in studying electric motors. For our present purpose we need concern ourselves only with such electric currents and such magnetism as we have to do with in continuous-current motors—that is to say, motors driven by a current of approximately steady flow in one direction. As current and magnetism are but two aspect of the same phenomenon, it matters little from which end we attempt to unravel their connection. Beginning, then, with the electric current, we must picture to ourselves that wherever an electric current is started in a conductor there is set up all round it in the medium—which has been postulated for the convenience of natural philosophers, and which they call the ether—a whirling disturbance. This disturbance is at right angles to the direction of the current, and seems to answer to the description of a vortex ring. The ring rotates with the current as its axis. It is supposed that this ring is made up of whirling electricity, so that it has, like the more visible and familiar vortex rings of smoke, two motions without change of position. The motion round the axis of the rings produces the phenomena of magnetism. We

Fig. 1.

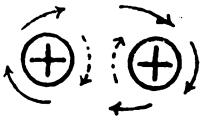

Fig. 2.

may then represent a section of our electric circuit as being surrounded by a whirl in a definite direction. It so happens that the direction of this whirl, in relation to the direction of the current, is represented in driving a right-handed screw home. Thus a current into the plane of the paper would have a whirl as shown by the arrow (Fig. 1). Now place alongside of it another conductor similarly carrying

* Paper read on December 18, 1894, before the Institution of Engineers and Shipbuilders in Scotland, and printed in the *Transactions* of the institution.

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current, and we have a whirl enclosing the two conductors, the stream of lines continuing in the direction of least resistance, as shown in Fig. 2.

The strength of this whirl, or whirls, which is what is called the magnetic field of the current, depends on the nature of the substance or substances through which it passes. In a path consisting entirely of air, its strength is very small. In a path consisting of iron or steel, its strength or intensity is very much greater. A group of such whirls might be represented thus (Fig. 3).

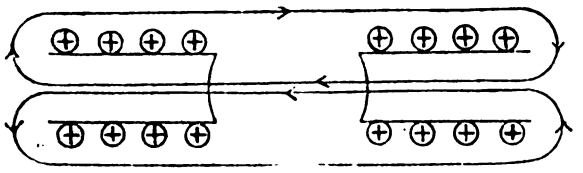

FIG. 3.

If, now, a conductor with whirls of its own be introduced into this group of whirls, or magnetic field, we are in a position to guess how it will behave (Fig. 4).

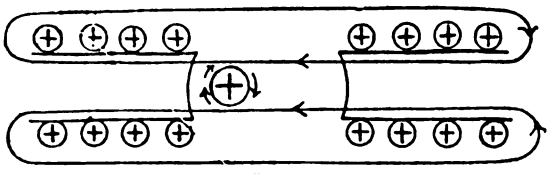

FIG. 4.

It will be seen that the whirl in the intruding conductor opposes the stream of lines on one side and adds to them on the other; the tendency, therefore, will be to move towards the direction in which it is pushed by the most lines. That is upwards in the case shown in the sketch. This is, in fact, the action of the electric motor. Electric currents are sent in from an outside source and made to flow in the directions indicated, and the result is motion in the direction shown. The aim, then, in designing an electric motor is to provide as nearly as possible a continuous iron path for the magnetic whirls set up by the exciting current, and so arrange the conductors carrying the currents to be moved across the magnetic field at right angles, that they shall interrupt this iron path as little as possible, and that they shall transmit the driving force to a point where it can be applied to do work. This is now practically accomplished almost universally by essentially similar methods. A portion of the iron path is mounted on an axis, and is free to revolve. On this portion are mounted the driving conductors, which transmit to the axis the force exerted by the interacting currents and magnetic field by exerting a turning force at the periphery.

To get this force applied as it is wanted, it is necessary to confine the electric current to the copper conductors, and to so mount those conductors on the core that they will transmit the forces to the shaft.

(To be continued.)

ARC LIGHT CARBONS.*

BY B. F. MILES.

Arc light carbons are to the electric arc lamp as the wick is to the oil lamp, or the burner to the gas-jet. The best arc lamp cannot send out its piercing light without a good carbon, while the best carbon in a poor lamp can only emit a feeble glow. One often has to bear the odium due to the faults of the other, but in both perfect combinations are necessary before the dark places of the earth can be made bright as noonday.

To the casual observer an arc light carbon is a very uninteresting object. It is usually a cylinder varying from $\frac{3}{16}$in. to 1in. in diameter, and from 6in. to 14in. in length. Its colour is a deep bluish-grey or black. Oftentimes they are coated very thinly with copper, nickel, or zinc, which completely changes their appearance. In most cities in this country the copper-coated variety is the one usually noticed in street arc lights, while in Europe the black, uncoated variety is almost wholly burned.

* *The Electrical World.*

These unpretentious little cylinders, however, have a long history, and the process by which they are made is an extremely interesting one. About 1810 Sir Humphrey Davy, in his researches in electricity, discovered that small cubical sticks of carbon whose points were separated from each other about the sixteenth of an inch, would emit a brilliant flash of light when a current of electricity was passed through them. These carbons were composed of powdered wood charcoal mixed with a little syrup of tar moulded into shape under a pressure of about a hundred pounds to the square inch, and baked in a crucible in a very hot fire. During the next 70 years numberless experiments were made in Europe and in this country to produce carbons from a variety of mixtures. The electric dynamo and arc lamp, not having been perfected until the closing years of the decade, 1870-80, the demand for carbon electrodes was very limited, their principal use being in scientific research; consequently they were only made by hand in two or three continental laboratories on the smallest scale, and at a very high cost. In 1876, the principal French maker sold his product at 35 to 40 cents each, a price that was practically prohibitive.

With the birth of the wonderful Brush dynamo and arc lamp a large commercial demand was quickly created, and how to supply carbons of high quality and at a low cost became a problem for electricians, second only in importance to the invention of the arc lamp.

The first step in this problem was to find suitable raw materials. Search had been made on both continents with comparative failure. Of the many sources of supply suggested, carbon produced in gas-retorts seemed the most feasible, but the varying impurities and refractory nature of this material had made it at best a makeshift. Till the fall of 1878, however, it was the principal source of supply, and carbons were still made in rectangular cubicular form with blunt ends.

The first American carbon manufacturer and his factory deserve mention here. This was David Thompson, of Newark, N.J., who died recently at a good old age. The writer remembers well calling on him nearly six years ago, and walking from his unpretentious little wooden house through his grape arbour to his small two-storey workshop. It was only about 20ft. broad by 30ft. long. A hand mortar, a rude brick oven and mixing pan, a hand bolting and grinding outfit, with a few iron and steel moulds, comprised his entire "plant." He still kept the small rectangular blunt iron moulds with which he made the first arc light carbons produced in this country, and spoke sadly of the business as having far outgrown his little means.

The present high position of the American carbon industry is due to two men, the celebrated inventor Charles F. Brush and Washington H. Lawrence, one of the founders with Mr. Brush, of the Brush Electric Company, and now president of the National Carbon Company, Cleveland, Ohio. While engaged in the invention of his arc dynamo, Mr. Brush had been investigating the nature of carbons and planning for their manufacture. In 1877, with Mr. Lawrence, he began a series of experiments on petroleum coke. After others had searched over two continents, it seems almost ridiculous that Mr. Brush found the desired supply of commercial carbon in its raw state within a mile of the Brush Electric Company's works; yet such is the fact. The Standard Oil Company for years had been burning up the last product of the distillation of crude oil, formed at the bottom of its paraffin stills. Shovelled from the stills in great lumps like the largest anthracite coal, it also resembles the latter at a little distance in its shiny, black appearance. It was this refuse product that was to help in giving the world its most brilliant light.

At first, Mr. Brush was puzzled over some properties of the new material. While it is pure carbon, it is also, like the purest anthracite coal, a non-conductor of electricity when in a raw state. After having heated the coke in a little crucible held in a forge fire, he found the non-conductor changed into a conductor, and the main result was gained. The balance of the experiments were conducted principally to ascertain the grain best adapted for burning in the electric current.

These results attained, it was decided that the best adhesive material to bind the particles of carbon together

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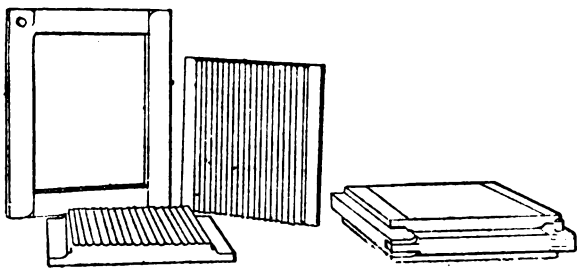
was coal tar pitch. This is the practice to-day, varied by such other slight additions as the experience of manufacturers have found to be advisable. These admixtures are kept as trade secrets, and as the carbon after moulding is baked at a very high temperature, it is very difficult to discover exactly what has been used.

The first large carbon works built still exist. It is the plant connected with the factory of the Brush Electric Company at Cleveland. From this plant many other factories have started. The writer believes all in this country have adhered closely to the materials which Mr. Brush determined as best for the business, and have followed closely the processes designed by himself and Mr. Lawrence.

These processes of manufacture may be summarised as follows: The petroleum coke is crushed and carried into retorts heated to a high temperature, where it remains from 10 to 50 hours, according to the result desired to be produced, thereby the moisture is driven out and the quality of conductivity imparted. Next, the carbon is carried to mills in which it is ground to a fine flour, next bolted and carried to a pan in which it is to be mixed with the "binding" material. All this seems very simple, but when one remembers that petroleum coke and diamonds are carbon, and that fine petroleum coke is nearly as hard as diamond dust, it is seen that the process requires exact machinery of great power, and that much care must be exercised in each of the subdivisions of the process. When in this stage, the carbon has the physical characteristics of the ordinary wheat flour of commerce, save that it is black.



MOULD FOR 7-16 INCH CARBONS.

In combining the carbon flour with the pitch, the latter is first broken up in an ordinary crusher, then transferred to mixing kettles or pans. The proportions of carbon flour, pitch, and its associate mixtures vary according to the "softness" or "hardness" of the carbon desired. These mixing kettles and pans are kept warm, and the entire mixture is constantly agitated by hoes, or other devices, from 15 minutes to an hour. This heat causes the particles of pitch to attach themselves to particles of the carbon flour, and at the completion of the process the mixture has the appearance of black pebbles of various sizes mixed with coarse black sand. After this mixture has cooled it is again crushed, ground, and bolted so that a flour of uniform grain is produced. The machinery employed for this purpose is somewhat different from that used in wheat flour mills, but the modifications would not interest an untechnical reader.

Thus far the process has not been of much interest to the ordinary observer. From now on the work becomes quite interesting. The material takes one of two courses, according as it is to be made up into "moulded" or "forced" carbons. If the first, the material is brought to men working at benches, who are called moulders. They are provided with steel moulds split in half, grooved according to the length and diameter of the carbon cylinders to be made. The steel of which these moulds is composed is of the finest quality, else it will not retain its shape under the tremendous pressure employed.

The moulder weighs the flour in a scale, distributes it evenly over the entire surface of the mould and upon it places the proper steel cap. The mould is then very slowly heated, which causes the particles of combined pitch and carbon flour to to take a form resembling thick paste. When the proper degree of heat has been obtained, the mould is taken from the furnace and placed under a hydraulic press, the pressures employed varying between 100 and 400 tons. From the presses the moulds are taken back to the bench, the cover and sides removed, and the card of carbons very carefully lifted off. When these cards of carbons become cool, each carbon is separated, and the little fin that has held it to its neighbour is scraped off each side, so that the carbon is left a perfect cylinder.

As mentioned above, the first carbons made were rectangular in cross-section with blunt ends. The modern practice is to make them cylindrical, with points more or less like the ends of a sharpened pencil. This change was suggested by Mr. Brush from his observations upon the shape which carbons acquired when burning in an arc lamp. He noticed that carbons whose cross-section is a circle cast much less shadow upon the surfaces to be illuminated than those whose cross-section is a square; also that all carbons burning in the electric arc tend to shape themselves like pencils, and do not form a quiet arc until they have assumed that outline.

The former observation could not be made the basis of a patent. The latter combines points of utility, both in cost of manufacture and in the initial half-hour of burning, and is the subject-matter of one of the Brush, also one of the Lawrence, patents which are still in force.

The majority of the carbons consumed in this country, being burned in lamps fed by a constant current, are made by the moulded process, to which they seem best adapted. In Europe, on the other hand, the majority of arc lamps are on constant-potential or alternating currents, and require a carbon whose particles are arranged differently from those in the moulded process, and also in many instances a core of less dense material to ensure steadiness of light.

The flour for carbons to be made by this process is treated somewhat differently than that of the moulded variety. It is usually shaped into cylindrical "plugs," about 6in. in length and from 2in. to 6in. in diameter. These are placed in front of the plunger of an hydraulic press of horizontal action and are forced through its jaws, taking any desired cross-section from the outline of the die at the mouth. As fast as the carbons leave the die they are received upon a table and cut to desired lengths. Should the carbons be "cored," a "core" or hollow about an eighth of an inch in diameter is left in the centre of the carbon as it passes through the die, by the action of a "tongue." This all can be readily understood by imagining the action of the human tongue and breath when ejecting a stream of water. The water corresponds to the carbon "plug"; the lips to the die at the mouth of the press; the breath to the press plunger forcing out the carbon; and the tongue tends to produce a hollow or core in the liquid stream.

(To be continued.)

HULL ELECTRIC LIGHTING EXTENSION.

A report has reached us from Dr. Holder, chairman of the Electric Lighting Committee of the Hull Corporation, in regard to a visit paid last week by the Hull and District Institute of Engineers and Naval Architects to the Hull Corporation electric lighting station and the setting in operation of a new engine and dynamo and motor generator. The ceremony of starting the new engine was performed by the Mayor (Alderman C. Richardson), and that of the motor generator by the Sheriff (Mr. P. T. Crook). Dr. Holder conceived the idea of making the visit and the starting of the new engine one event, and, in response to his invitation, a large body of gentlemen attended at the station in Dagger-lane. The ceremony that evening marks another step in the progress of the Corporation electric light supply, which in the short space of time it has been opened has achieved remarkable success. The station was opened on January 16, 1893, to supply the old town of Hull. In response to a general request in the latter part of the same year, the supply was extended west of the docks. The larger demand necessitated last year an enlargement of engine and dynamo power, and a condensing plant, and now the installation of a new engine and dynamo and motor generator. The cost of the equipment of the station and service, which in 1893 had cost £23,072, has been nearly doubled, since the subsequent additions have brought its present cost up to nearly £40,000. Comparing the end of the year 1893 with the end of 1894, we find that the engine power has been increased from 560 to 860, and the capacity of the dynamos from 2,600 amperes to 4,200 amperes. The rapid growth of the demand and the general popularity of the light with the public may, in some measure, be gauged by the fact that the lamps connected in-

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creased in the year from 8,035 to 14,208 of 8 c.p., and the units delivered to customers 74,600 to 163,357, the users increasing from 148 to 271. Thus, while the capacity of the station has been increased by a little more than half, the output has more than doubled. In the time under review efforts have been made to popularise the light by reducing the price from 7d. per unit to 6½d. for lighting, and 5½d. for places of worship, and from 6d. to 5d. for motive power.

Amongst those who were present were the Mayor (Alderman Richardson), the Sheriff (Councillor Crook), Mr. F. H. Pearson (president of the Engineers' Institute), Aldermen Wilde and Fraser, Councillors Skinner, McGaw, Shaw, Wharram, Wise, Ross, Marshall, Moulds, Broadberry, Newham, Laverack, Calvard, Brown, Butterworth, Briggs, Millington, Bell, Parrott, Cohen, Feldman, Simpson, Messrs. R. G. Reeks (Admiralty surveyor), M. Samuelson, J. R. Smith, J. Spear, W. Harris, E. Williamson, F. C. Brentano, Dr. Riley, T. Rose, C. Clark, G. Clark, J. H. Charlton, J. Mills, J. Innes, R. W. Carson, W. Cooper, H. McInnes, G. H. Strong, W. H. Willatt, Beath, R. Good, R. Hill Dawe (town clerk), W. H. Milner (borough treasurer), W. Linney, J. G. Hall, and W. Wheatley.

Dr. HOLDER, in the course of a short introductory address, said that Wednesday was their birthday. January 16, 1893, was the first time that they delivered a unit of electricity, and they were thus two years old. Unlike all other committees of the Corporation, they made up their accounts on December 31, and, therefore, their second year had just been completed. In their first year they delivered 74,000 units of electricity, and during the second year they had increased that by more than 100 per cent., their delivery being 163,000 units. Their income for the first year was about £2,200; last year, at a lessened charge, it was £4,800. In their first year they paid their way in an extraordinary degree, and Hull held the record of England for economical working. They paid every penny for upkeep, maintenance, taxes, interest, and everything, and had the nice little sum of £130 profit. The second year had been better. The accounts were not fully made out, but he had gone through the matter carefully in his own mind, and with the assistance of the borough treasurer, and it enabled him to say they had done exceedingly better, and would hold the record for economical working against any station which had been in existence for that time. They would not only be able to pay upkeep, interest, etc., but a twenty-fifth part of their capital, and have a few hundreds of pounds profit. He had been asked to give the reasons of the success of the station. The first was the wisdom of the Council in allowing two or three practical members—a builder or two, an artisan who was well acquainted with brick and timber work, and their friend Mr. Laverack—to visit different stations in England. When they went away they were helped by one of the members of the institute who was paying them a visit that night (Mr. Willatt), who lectured them all the way up and down, so that they knew, whatever station they were going to, what were its merits, where they were to look for what was wrong, and what they were to ask for. Through that committee the Corporation were made acquainted with the best plant, and that had conduced much to its success. The second point was that they knew what kind of an engineer they wanted, and how far they ought to trust him; and that they had had in Mr. Herman Lewis and his successor (Mr. Gibbings) two of the best electrical engineers in the country. The third element of their success was that they knew what class of plant they wanted, and who were the best manufacturers. They did not go to cheap people, but to good people, and that, he believed, was really the foundation of their economy in working.

The MAYOR extended a hearty welcome to the visitors. Mr. Holder had referred to the reasons why the station had been a success, but he (the Mayor) thought it was generally admitted, both in the Corporation and the town generally, that one reason why it had been so successful was that Mr. Holder had been the chairman of the committee, and had thrown into the work that enthusiasm which was essential to its success. Many present would perhaps remember the first introduction of electric light to Hull, and how unsatisfactory it proved, and how expensive it was to the ratepayers. The reason why that attempt was unsuccessful was, he thought, because it was not carefully considered at the commencement, and because the plant which was put down was of an unsuitable character.

Mr. PEARSON returned thanks for the kindly welcome they had received, and said that, when it was suggested several of the members would like to look round the station, they never expected they would be asked to a function like that. Some gentlemen would sit at the head of the committee, and do the routine work, but not the detail work, but he believed Mr. Holder had gone into the matter fully, and was as well acquainted with the subject as any non-professional man could be.

Mr. GIBBINGS, the electrical engineer, explained the working of the station.

The company, who had assembled in the battery-room, then adjourned to the engine-room, where Mr. Skinner, the deputy-chairman of the committee, asked the Mayor to start the new 300-h.p. engine and dynamo.

His Worship turned on the steam, and the large engine started working. The Sheriff next started the new motor generator. After an inspection of the machines and apparatus contained within the station, refreshments were served in the drawing office.

Mr. PEARSON moved a vote of thanks to Mr. Holder, which Mr. SAMUELSON seconded.

Dr. HOLDER replied, and the health of Mr. Gibbings, the electrical engineer, was also honoured.

RESISTANCE WIRE.

The Westphalian Rolling Mills (Messrs. Fleitmann, Witte, and Co.) of Schwerte, have appointed Mr. Al. Demaret, of 4, St. Mary-axe, as their representative in this country. The latter has forwarded us the following translation of a certificate of test which the Westphalian Rolling Mills received from the Imperial Institute at Charlottenburg:

Certificate of Test of Sixteen Kinds of Wire.

The Westphalian Rolling Mills (Fleitmann, Witte, and Co.) delivered on February 1 of the present year to the Imperial Institute 16 coils of wire, 0·02in. diameter, distinguished by numbers, together with a list containing the designations stated below, and the degree of hardness, for the purpose of being tested for specific resistance The test was made in the following manner: A piece of the wire was soldered at both ends to copper blocks, and then, after its length and cross-sectional area had been determined, the wire was wound on a strip of mica, and heated in a drying-chamber for 24 hours at a temperature of 130deg. Celsius (266deg. Fahrenheit). The resistance of this piece of wire was then measured in a petroleum bath at two different temperatures according to the Wheatstone method.

From the values thus obtained the following figures of the specific resistance and the variation of the same with the temperature were calculated:

Designation.	No.	Condition.	Resistance in microhms of a length of 1cm. (0·39in.) and a cross-sectional area of 1 sq. cm. (0·016 sq. in.) at 20deg. Celsius (68deg F	Variation of resistance by increase of 1deg Celsius (1·8°F.
Patent resistance wire Ia. Ia.	2	Hard.	50·2	−0·000011
Patent resistance wire Ia. Ia	12	Soft.	47·1	+0·000005
Patent nickeline wire I	3	Hard.	43 6	+0 000076
,, ,,	13	Soft.	40 7	+0 000077
Patent nickeline wire II	4	Hard	33 9	+0·000168
,, ,,	14	Soft.	32 3	+0 000181
German-silver wire.....	7	Hard	38·8	+0 000187
,, ,,	17	Soft.	39·3	+0·000195

A new quality, called "superior," was also sent for testing. The results were as follows:

Specific resistance in microhms of a length of 1cm. (0·39in.) and a cross-sectional area of 1 sq. cm. (0·016 sq. in.).	Coefficient of temperature.
86	+0·00072

PROPOSED RESUSCITATION OF WOODHOUSE AND RAWSON UNITED.

The Industrial Inventions Development Company.

We have received two circulars in regard to the Industrial Inventions Development Company, Limited, the object of which appears to be to resuscitate some of the business of Woodhouse and Rawson United, Limited. The first circular, which emanates from Mr. F. L. Rawson, is addressed to the shareholders and creditors of the United Company, and is as follows:

Since Woodhouse and Rawson United went into liquidation, nearly the whole of my time has been devoted to endeavouring to save the most valuable assets for the shareholders and creditors. It was inevitable that in the hands of a receiver the time which was absolutely necessary for the favourable realisation of assets could not be given, and that the bulk of the company's property would have to be sacrificed for almost any price that purchasers might choose to offer. But in the patents invented and perfected by my brother, Mr. W. Stepney Rawson, who was for many years our head technical expert, I came to the conclusion that there existed a source of large future profits, and that by their means the shareholders and creditors might in time recover a considerable part of their losses. This view has been borne out by subsequent experience. In addition to the metal pickling patents, Mr. W.

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Stepney Rawson has, since the liquidation of the company, patented, with Mr. Richard Heathfield, a system of galvanising by electricity. Mr. Heathfield is a practical galvaniser with some 30 years' experience, holding an admitted position in the trade. Being satisfied that electric deposition must largely supersede the present system of galvanising by dipping in molten metal, and be a most valuable invention, I some time ago obtained the option referred to in the accompanying circular with a view to offering the benefit of such option to the shareholders and creditors of Woodhouse and Rawson United. Upon the necessary plant being erected at the works of the best known firm in the trade in England, the anticipations of the inventors were fully realised. The date by which the option had to be exercised was 14 days after the process was successfully at work, and as by that time I had not been able to complete my arrangements for the formation of this company, I exercised the option myself and bought the interest in the patents. This interest has since considerably increased in value. I now beg to state that I hand over to the new company the benefit of this purchase on the same terms, and will give the company such time as the directors may require to examine the various processes before deciding to take over the contract. The accompanying circular, with the statements in which I agree, shows the valuable nature of the rights and the importance of the patents, and the profits should be exceptionally large, having reference to the small amount of capital—namely, £7,000. I may add that Mr. J. W. Hughes, who has joined the Board of the new company, is the sole partner in the firm of Messrs. Hughes, Chemery, and Co. This firm has a large business abroad in connection with the metal, tinplate, and iron trade, and Mr. Hughes has had great experience in developing continental patents both for tinning and galvanising. He also has considerable experience in the steel trade, being a director of the highly-successful Harvey Steel Company of Great Britain, Limited. It has been proposed that I should join the Board, but I prefer to offer myself for election at the statutory meeting.

The second circular, bearing the signature of Mr. F. Dever-Summers, secretary (*pro tem.*) of the new company, and sent from 88, Queen Victoria-street, E.C., is substantially as follows. It is also addressed to the shareholders and creditors of Woodhouse and Rawson United:

During the last 18 months Mr. F. D. Leslie, the receiver for the debenture holders of Woodhouse and Rawson United, Limited, has been developing various inventions in which that company is interested. These are the subject of 12 letters patent and five provisionals, and are as follows:

(1) *W. S. Rawson's Electric (Metal) Pickling Patents.*—In the processes known as galvanising, tinning, leading, enamelling, etc, it is necessary to first remove the oxide, or, as it is called, the scale before dipping the pieces to be coated into the hot metal. This is called pickling, and at present is done by immersing the metal in strong acid, which has this disadvantage, that it not only removes the scale, but attacks the clean metal underneath. By the above invention the articles are placed in a weak solution of acid, a current of electricity is set up in the bath which rapidly removes the scale, and without the usual action on the surface of the clean iron or steel. Besides requiring less acid to remove the effect the removal, the waste acid is largely reduced, thus effecting a substantial saving and rendering the waste liquor easier to deal with. A royalty varying from 3d. to 1s. per ton will no doubt be obtainable, which ought to realise a large annual sum, as there are considerably over a million tons of articles per annum treated in the United Kingdom alone, and to over 400,000 tons of this the process is already applicable in its present stage of development. Further applications are being worked out. One of the largest manufacturers in the Black Country has just erected a plant, under license for this process. On account of its greater cleanliness the invention is specially adapted to the cleaning of wire and of plates for enamelling, and a modification of it has been successfully applied to the cleaning of brazed work, such as the joints, tubes, and other parts of bicycles. A firm of Birmingham bicycle manufacturers have had the process at work for nearly 12 months, and at the offices of the company can be seen a highly satisfactory written testimonial from them, both as to the quality of the work and the saving in expense. Hundreds of pieces have also been treated in London at highly remunerative prices.

(2) T *and* U *Smooth-Running Wheel Patents.*—These patents covers the inventions of Messrs. Aves, Bonn, and W. S. Rawson for combining permanent rubber cushions with a continuous T or U tyre in a wheel without felloes; in the case of the U-tyre it is fitted with wooden blocks to still further diminish shaking and noise. The invention is not fully completed, as the newest form—namely, the U-tyre with the wooden blocks for specially easy running—has still to be worked out. Mr. Bonn is manufacturing the latest form of wheels at his own works, and they will be ready within a week.*

(3) *W. S. Rawson and F. L. Rawson's Incandescent Gaslight Patents.*—This invention is for temporarily hardening mantles, such as those used in the well-known Welsbach incandescent gas burners, and rendering them less liable to fracture during their transmission from place to place. The invention has been fully worked out, and is thoroughly effective.

The following patents have also been worked out by Mr. W. S. Rawson:

(4) *W. S. Rawson and R. Heathfield's Galvanising Patents.*—These patents are for galvanising or covering with zinc in a cold state, by electro-deposition, iron and steel articles which at the present time are galvanised by being dipped in molten zinc, which is a very wasteful operation. Galvanising by the hot process divides itself into two branches: the first for plates and wire, where a certain amount of the unnecessary zinc can be wiped off and used again; the second for articles, such as screws, etc., where this is impossible. In the hot process far more zinc is put on than is necessary; by the above new cold process any given quantity or thickness of zinc can be uniformly distributed by electro-deposition over the surface of articles, however small, thus enabling many kinds of work to be treated which at present cannot be covered with zinc The saving in cost is large, as, beside the above gain, no oxide or dross is formed; and, further, when the plant is standing there is no waste of fuel or metal as at present, and the large quantity of muriate of ammonia, now used as a flux, is entirely saved. The present cost of hot galvanising varies from £2. 15s. to £4. 10s., and in special cases as much as £6 per ton, whilst by the new process the cost is estimated to be only from 25s. to 45s. per ton. Not only is the zinc far more evenly distributed, but some classes of work can now be coated which previously had to be left bare, and as it is a cold process, the iron or steel is not deteriorated by immersion in molten metal as in the hot process. Half a million tons per annum is a very moderate estimate of the articles capable of being treated by this process in the United Kingdom alone, of which at least 50,000 tons belong to the second branch mentioned above. One of the largest manufacturers of the latter class of work in Birmingham has erected a small trial plant capable of turning out about half a ton per week, which has been at work about two months with results even more satisfactory than was anticipated. Numerous applications have been made with regard to the use of the process for various kinds of work; for instance, by one of the leading firms of telegraph fitting manufacturers for a plant up to 30 tons per week, and by two large tube manufacturers turning out between them 20 to 30 tons per week of galvanised fittings. An application has also been received from the Continent for its use in connection with important military work, for which experiments already carried out have proved it to be particularly suitable. One of the principal railway companies has for some time past been making tests on the suitability of the work for certain railway fastenings, which, up to the present, it has not been possible to galvanise. The directors believe that one part of the galvanising patents will be usefully employed in the electro-plating industry in connection with other metals than zinc and negotiations between the patentees and one of the largest firms of electro-platers in England tend to confirm this.

(5) *W. S. Rawson and R. Heathfield's Zinc Recovery Patents.*—Scrap galvanised iron, for which there is at present little or no use, is put into a bath and a current set up which causes the zinc to pass into the solution. From this solution the zinc can be caused to pass on to the surface of new work, where it is equal to the best virgin spelter. Spelter dross, of which there is an unlimited supply, can also be used, at a cost of over £3. 10s. per ton less than virgin spelter, which costs about £15 per ton.

(6) *W. S. Rawson and R. Heathfield's Electric Renovating Patents.* By this process it has been found that rusty scrap, such as bolts and nuts, the value of which is almost nominal, can be successfully treated at a very small expense and rendered almost equal to new work, provided the rust has not actually eaten into the metal. A testimonial with regard to the results of work already carried out can be seen.

The interests of Woodhouse and Rawson United in the first three sets of patents above mentioned are as follows: (1) metal pickling patents, 60 per cent. of English and foreign rights; (2) T and U wheel patents, one-third of English and foreign rights; (3) incandescent gaslight patents, the entire English and United States rights.

Mr F. L. Rawson has for some time been negotiating with Mr. Leslie, endeavouring to save the most valuable assets of that company for the shareholders and creditors, and on the 14th ultimo he made, with the approval of the Court, an agreement with him to acquire the above interests for the sum of £1,500. This purchase, by agreement dated the 16th instant between himself and this company, he now hands over to this company without any profit to himself, he being only paid his out-of-pocket payments and expenses in connection with the above. With the exception that in the renovating process one of their patents is used, Woodhouse and Rawson United have no interest in the latter three sets of patents, Nos. 4, 5, and 6, which are owned by Mr. W. Stepney Rawson and Mr. Richard Heathfield; but in order to help the shareholders and creditors of Woodhouse and Rawson United, Mr. F. L. Rawson obtained the consent of Mr. W. S Rawson and Mr. Heathfield some time since to give this company, when formed, a 10 per cent. interest in the English patents, together with the option referred to below. These, the directors believe, are of great value. The option above mentioned is an option of taking out the various foreign patents of Mr. W. Stepney Rawson and Mr. Richard Heathfield (with the exception of those for the United States)—that is to say: (4) the galvanising patents; (5) the zinc recovery patents; (6) the electric renovating patents, and acquiring for the sum of £2,500 a 40 per cent. interest in the same, together with (7) the sole right of treating, or licensing others to treat, old material by the renovating process in the United Kingdom, taking one-fourth of all profits made therefrom; and (8) the sole right of galvanising job work in London, subject to the payment of a royalty of 10s. per ton to the patentees.

* Mr. Bonn has since written to the directors to say that he has completed his work, and that he has not the slightest hesitation in saying that the wheel will be a great success.

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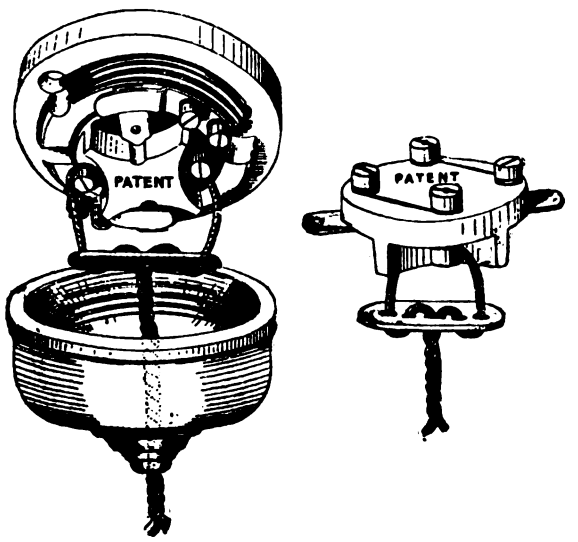
Mr. F. L. Rawson having, in order to secure the benefit of the option, exercised it himself by agreement with R. Heathfield and W. S. Rawson, dated November 21, 1894, and has arranged with the directors that this company shall have 14 days after the date of allotment for deciding whether they will take it over, on the same terms as paid by him. They are having the processes Nos. 4, 5, and 6 reported upon by an independent expert, and before finally deciding they will hold the statutory meeting of this company and lay the result of their investigations before the subscribers. It is not intended to confine the operations of this company to working the above patents. Woodhouse and Rawson United and its predecessors have for many years carried on, under Mr. F. L. Rawson, the business of developing and placing the patents of inventors and it is believed that this department has been always well and carefully managed. This class of business will be continued by this company. A detailed report has been made with reference to all the patents (except the wheel patents), and many of the statements herein are based thereon. The report itself can be seen at the offices of the company by any intending subscriber. No contracts have been entered into by this company except that of the 16th inst. mentioned above, which can be seen at the offices of the company. On October 16, 1893, Mr. F. D. Leslie made an agreement with Messrs. R. Heathfield and Son, whereby they agreed to act as agents for the licensing and dealing with the metal pickling patents, receiving therefor 10 per cent. of the profits The benefit of this agreement the company takes over. By agreement dated August 22, 1893, between Mr. F. D. Leslie and Mr. W. S. Rawson, the latter undertook the working out and development of the pickling patents at a moderate salary and 30 per cent. of the profits made. The company has the option of taking over this agreement. Failing the taking over of the agreement and the payment of the salary, Mr. W. S. Rawson will become entitled to an additional 15 per cent. of the net profits from the pickling patents. Sundry agreements with regard to the working of the inventions on royalty and defining the interests of the inventors between themselves have been made, which may be considered contracts within Section 38 of the Companies' Act, 1867 It is obviously undesirable that particulars of these should be given, and subscribers shall be deemed to have waived any further compliance with the said section. The capital of the company is 50,000 shares of £1 each, of which 7,000 are now offered for subscription to shareholders and creditors only of Woodhouse and Rawson United, Limited. The directors have sent in applications for 1,000 shares.

NEW DETACHABLE DOUBLE-POLE CEILING ROSE.

The accompanying illustrations, which represent a new ceiling rose brought out by Messrs. Cutting Bros. and Co., of Derby,



clearly show the advantages of this article. It will be seen that the construction of the rose, which is of the double-pole detachable type, allows of good connections being made in the workshop and easily examined and tested before erection; whilst at the same time all flexible pendants can be readily made exactly the same length, a matter of some importance in economy of labour when several pendants are placed in the same room. Among the advantages claimed for this ceiling rose may be mentioned that it affords a high insulation; that pendants connected with it can be removed in a moment, and replaced by the most inexperienced; that as the movable part is enclosed, and as there is no external metal work, the rose fully meets the requirements of the fire offices; and that it is specially adapted for shop window illumination or for other positions where lamps require frequent removal. The ceiling rose is provided with the company's adjustable cord grip, which it is stated will sustain any weight to the breaking of the cord without in the least disturbing the electrical connections.

CABLE REPAIRING.

We have been favoured with a copy of a Boston paper bearing the date of December 10, 1894, and containing a report of an interview which a representative of that paper had with Captain S. Trott, of the "Minia." The following extracts will be read with interest:

"This business of cable repairing," Captain Trott said, "is a science in itself. It would take hours to explain the thing thoroughly. You have asked me several questions, none of which are easily answered. You spoke of anchoring at sea. We do not anchor. To start with, supposing we are ordered to repair some break. We get the location as near as possible from those on shore, and proceed to the spot. We then lay about and place a buoy in position. The ship is kept under steam while we are there, and we keep our position as well as possible. We then take soundings to see what the bottom is like, and then drag for the cable with a grapnel until we hook it. Mind you, if the cable is in deep water that cannot be done. You cannot hook it and pull it up, because there is not slack enough to bring a bight to the surface. The cable, therefore, must be cut or broken unless we can get near enough to the break and pull up one end. Now, all this sounds very easy while I am telling you about it, but when you come to do the thing it is a different matter entirely. Allow me to give you an example. In July, 1893, one of the Anglo-American cables—the company I am employed by—broke. At the time I was out repairing one of our cables, one of the oldest by the way, having been laid in 1869. After completing my work I went to England for more cable to repair another break. When we got part on board our 1874 cable broke (you see we name our cables by the year they are laid), and another ship was hired to go out and repair it. She took the 100 miles of cable destined for us, half of which we had on board. We had to remain in England until another 100 miles were manufactured for us.

"In the meanwhile the 'Calabria,' double the size of us, had gone to repair the 1874 cable. She started in July, and was over 100 days at it. Once during that time she lifted one end, spoke the shore, and spliced one piece of new cable. When they commenced to pay out the cable broke, and, if my memory serves me right, it was on board ship. They lost it, and never recovered it again for that year. It sunk in 2,400 or 2,500 fathoms of water. There's one example for you. In October I was in St. John's and was ordered to proceed to England, I having told the manager that it was impossible to recover the cable that year. The 'Calabria' also went to England, the manager having agreed to what I said. All they had done was to break pieces off. This summer we were ordered to do the work and we did it. It has been our summer's work. Beyond doubt it was one of the most important ever accomplished."

"You are right, captain," an officer broke in; "and if you have too much modesty to say anything, I have not. They sent Captain Trott," he exclaimed, "because he never in all his life has failed to accomplish anything sent on."

"Well, that's neither here nor there," resumed the captain. "We were in lat. 49.50 and long. 40.30, so that'll give you some some idea of where we lay. We went to work in May, about the 20th, and it took us till nearly the end of July before we had completed the work. We had a lot of nasty weather, and one of the greatest difficulties I ever encountered, and one that I had least expected, was a strong stream running to the north-east. We, however, managed to complete the work, and that's all that need be said about it. The 'Faraday,' I learn, has put into Penzance, England, within a week. She was on one of the Gould cables, which is leased by the Western Union. She was working in long. 40, somewhat further south than we were. She failed. Like the 'Calabria,' she got one end, and that's all. They wanted me to take that job, but I was of the opinion that it could not be successfully performed. I have been engaged on different cables lately, and have just finished work on the Duxbury cable."

LEGAL INTELLIGENCE.

GLOBE DEBENTURE SECURITIES CORPORATION, LIMITED, v. ELMORE'S FOREIGN AND COLONIAL PATENT COPPER DEPOSITING COMPANY, LIMITED.

Mr. Justice Chitty, on the application of the plaintiffs, being debenture-holders of the defendant company, has made an order appointing Mr. C. W. Grimwade receiver of the property of the company comprised in the debenture security.

BURROWS v. PRIESTMAN BROS., LIMITED.

This was a debenture-holder's action relating to the company who manufacture oil-engines. Messrs. Watson and Hodson have been appointed receivers and managers. It was stated that a meeting was being held by shareholders to consider the advisability of winding up the company voluntarily.

PREFERENCE SHARE QUESTION.

In the Chancery Division on Saturday, Mr. Justice Romer dealt with a summons on behalf of Mr. Henry Percy Hope asking to have his name removed from the list of the members of the Electric Construction Corporation, Limited, and the list of contributories

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in respect of 44 preference shares in the company. The applicant's case was, in the first place, that he had never made any application for the shares. That was not disputed, but Mr. Courtney said there was a tacit understanding amongst the directors, of whom Mr. Hope was one, that they would take a certain proportion of preference shares. The understanding in this particular case appeared to be that at a meeting of the Board, at which Mr. Hope was not present, the chairman said he supposed every director would take a fair proportion of shares. No director said he would not, and that was what was relied on as the tacit understanding that Mr. Hope, who was not there, would do so. The second point was that it was suggested that a letter of allotment was sent to Mr. Hope and that he did not return it. It was doubtful, it was contended, if such a letter was sent, and certainly Mr. Hope never received it. And further, though there had been several calls made in 1892, no notice was sent to Mr. Hope and he never paid any of them, or knew that his name was on the register until after the winding up in 1893, when the liquidator wrote to him. These facts were not disputed by Mr. Theobald, who appeared for the company, and his lordship thereupon directed that the register be rectified by the removal of Mr. Hope's name, and ordered the liquidator to pay the costs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Saint-Dié (Vosges, France).—The Municipality invite tenders by February 1 for the concession for a central electric light station for the town.

Louvain (Belgium).—Tenders are invited by February 1 by the local authorities at the Hotel de Ville for a concession for an electric tramway from the railway station to the Grand Place, Louvain.

Newport (Mon.).—Tenders are invited for complete electric light installation for the Museum and Art Gallery, Dock-street, in accordance with plans and specifications, which may be seen upon application to Messrs. Swash and Bain, architects, Friars-chambers, Newport.

Lisbon.—Tenders are invited by 31st inst. for telegraphic apparatus and porous jars by the Royal Portuguese Railway Company, of Lisbon Particulars are obtainable from the bureau of the Compagnie Royale des Chemins de Fer Portugais, 28, Rue de Châteaudun, Paris.

London, E.C.—The County of London and Brush Provincial Electric Lighting Company invite tenders for the erection of central-station chimney shaft and other buildings at Oak Wharf, City-road, E.C. The plans, etc., can be seen at the offices of Mr. C. Stanley Peach, 8, John-street, Adelphi. Tenders must be sent in not later than February 4.

Manchester.—The Moss Side School Board invite tenders for the installation of the electric light in their schools in Princes-road, Moss Side. Plans, etc., may be obtained from Mr. S. V. Clirehugh, A.M.I C E., Temple-chambers, Brazennose-street, Manchester, on and after 28th inst., on payment of £1. 1s., which will be returned on receipt of *bonâ fide* tender. Tenders are to be sent by Wednesday, February 6, to Mr. W. E. Rowcliffe, clerk to the Board, 30 Cross-street, Manchester.

RESULTS OF TENDERS.

Southport.—The tender of Messrs. Morster and Wright, of Southport, has been accepted for bricklayers' labour for building walls at the electricity works with bricks set in Portland cement, at 4s. 6d. per cubic yard.

BUSINESS NOTES.

Woking.—A dinner has been given at the Masonic Hall by Messrs. New and Mayne to their employés.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,670.

Taunton.—The borough accountant states that loans have been sanctioned for the electric light works amounting to £5,000.

Bedford.—The Corporation have under consideration the question of extending the mains, there being an increasing demand on the part of private consumers.

West India and Panama Telegraph Company.—For the two weeks ended January 15 the receipts show a decrease of £354 as compared with the corresponding period of 1894

Croydon.—The High-street Special Committee of the Town Council have been instructed to obtain tenders for wiring and supplying electric light fittings for the Town Hall.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 20th inst. amounted to £900, as compared with £656 in the corresponding week of last year.

St. Pancras, N.W.—The Electricity Committee formally reported to the Vestry last week that Major Cardew had held an enquiry respecting the recent explosion, and that he would report later.

New Showrooms.—Messrs. Swinburne and Co., of Teddington, announce that they have now opened a showroom and offices at 66, Victoria-street (2, Prince's-mansions), S.W., where all communications should be addressed.

Copper.—The stocks of copper in England and France fell from 50,764 tons on December 31 to 50,267 tons on January 15, and the amount advised from Chili and Australia is 100 tons less, there being the decrease in the visible supply of 597 tons.

New Rubber Company, Limited.—This Company has been registered, with a capital of £35,000 in £1 shares, to carry on business as manufacturers of and dealers in rubber, guttapercha, and other elastic substances, and to produce and use electricity.

New Swindon.—The Town Council have referred to the Streets and Lighting Committee the question of appointing a committee to deal with the question of electric lighting. The names of Mr. D E. Marsh, Mr. Churchward, Mr. Deacon, and Mr. Protheroe have also been added to the committee.

Cardiff.—The electric light in the Town Hall buildings was switched on for the first time on Thursday of last week, on the occasion of the Mayor's banquet. The work has been carried out by Messrs. Fergus and Co., of Mount Stuart-square, Cardiff. There are 400 lamps, which are controlled by a main switchboard.

City and South London Railway.—The receipts of the Company for the week ended January 20 were £996, against £947 for the corresponding week of 1894, or an increase of £49. The total receipts for the current period of the present half-year are £3,001, against £2,888 in the corresponding period of 1894, an increase of £113.

Huddersfield.—It was mentioned at a recent meeting of the Town Council that in January, 1894, the number of consumers of the electric light was 89, with 8,229 8-c.p. lamps connected; in January, 1895, the number of consumers was 214, with 15,342 8 c.p. lamps, or an increase of nearly 7,000 lamps in the 12 months.

Buxton.—Trunk line telephonic communication has now been established from the Buxton Post Office to Manchester. The construction of the line and the fixing of the switchboard has been carried out at Buxton under the supervision of Mr. J. E. Owens, Derby, whilst the Manchester portion of the work has been carried out by Mr. T. Hughes.

Maidstone.—The Town Council last week postponed to the next meeting a resolution moved by Mr. Morling that the Council should endeavour to dispose of the electric lighting order by tender, the conditions to be settled by the Electric Lighting Committee. Mr. Morling moved the resolution in order to stir up the Electric Lighting Committee.

Sunlight Incandescent Gas Lamp Company, Limited.—This Company has been registered, with a capital of £15,000 in £5 shares, to carry into effect an agreement made with L. Oliver, and to carry on business as manufacturers and dealers in lamps, and all materials in connection with gas fitting and gas lighting, and appliances for electric lighting.

Southwark.—The St. George's (Southwark) Vestry have decided to ask the Board of Trade not to sanction large transformer-chambers in the public highways, such being regarded as dangerous. This is, however, a little late in the day, the Board of Trade having already given permission for the construction of such chambers, as stated in our last issue.

Paddington, W.—The Electric Lighting Committee of the Vestry reported last week that having considered the application of Mr. Whiteley to fix electric lamps outside his premises in Queen's-road, they instructed the surveyor to ascertain certain particulars from Mr. Whiteley's engineer, and such particulars being satisfactory, the application had been granted.

Douglas.—A public meeting was held at Douglas on Monday to consider the advisability of establishing a tram service to the upper part of the town. A resolution was passed declaring that, owing to the depreciation of property in the upper part of Douglas, the time had arrived for a tramway service; that the Town Commissioners be called upon to take immediate steps to carry it out; and that the district benefitting contribute on the betterment principle towards any loss.

Coventry.—The Electric Light Committee of the Corporation recently advertised for tenders for the supply of meters of various sizes. Messrs. Chamberlain and Hookham, Limited, Birmingham, sent in the lowest tender for 60, and the committee recommended its acceptance. The price was £270. 10s., and £20. 14s. for testing the meters. Alderman Hill moved at a meeting of the Council the acceptance of the committee's report. Mr. West seconded, and the Council approved unanimously.

Blackburn.—The Gas Committee of the Blackburn Corporation recently appointed Mr. A. S. Giles borough electrical engineer. The work at the central station, which has been carried out under the superintendence of Mr. E. M. Lacey, who was appointed consulting engineer in September last, is nearing completion, and the Corporation expect to be in a position to supply current in the course of the next two or three weeks. Applications for upwards of 1,800 lights have already been received.

Luminous Enamel.—The Luminous Enamel Syndicate, of 37, Cursitor-street, Chancery-lane, E.C., have sent us a copy of a circular referring to their luminous enamel. They claim that when applied to incandescent lamps this enamel entirely hides the filament, renders the light a bright white and soft to the eyes, and that it increases the illuminating power of the lamp. The enamel is made in different colours, and it can be put on in ornamental figures and flowers. The enamel is said to be also particularly suitable for arc lamp globes.

Edinburgh.—The second annual soirée and concert of the workmen of the Edinburgh and Leith Corporations Gas Commissioners were held a few days ago at Leith. Bailie Manclark (the chairman), referring to the electric light, said they were likely to have a

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strong opponent in that. They would have to do their level best to turn out gas at the lowest possible price. Some of the larger consumers in Edinburgh were sure to go in for the electric light. They would require by mechanical stoking and water and oil gas to compete with electric light, and show there was nothing like gas.

Warning.—Messrs. Russell and Co. write to a daily paper stating that a man representing himself sometimes as a traveller of that firm and sometimes as a certain Russell, of Melbourne, has been ordering on their behalf or giving their name as a reference for orders for carriages, tobacco pipes, and fireworks. He does not appear in any case to have actually obtained any property or money, but, as the man is probably an impostor, Messrs. Russell and Co. state that it would be as well if the next firm on whom he calls were to detain him until the police had had an opportunity of making his acquaintance.

St. Luke's, N.—The attention of the Vestry was called last week by Mr. Leage to the state of the pavements in that part of the City-road where the electric lighting company are laying mains. He stated that the pavement was impassable. Mr. Pond and Mr. Walsh made similar complaints with regard to the condition of the parts of Central-street and Old-street. The surveyor remarked that there had been already five or six days' frost, in consequence of which the pavement works were suspended, as it would be useless to carry them on in such weather. The matter was left in the hands of the surveyor.

Dublin Tramways.—The Dublin United Tramways Company on Tuesday approved of the introduction of a Bill providing for the use of electric power on the Dublin street cars. The Chairman (Dr. Carte, J.P.) said they had examined the systems in use in Paris, Brussels, and Frankfort, and had come to the conclusion from what they saw that the days of horses in street cars were numbered. The electric system was better and cheaper, and they hoped that the Dublin Corporation would give them every assistance in introducing it. They believed, from what they saw, in the system of overhead wires, and they intended, if power were given and subject to the advice of experts, to introduce it on the Clontarf line.

Brighton.—The minutes of the Lighting Committee, presented to the Town Council last week, mentioned that at a meeting of the committee on December 31 a letter was read from Councillor Blaker requesting the committee to reconsider the question of lighting the Marine-parade by electricity, but it was resolved to inform Mr. Blaker that the committee saw no reason to withdraw their recommendation. The committee agreed to accept the offer of the successors of Latimer Clark and Co. to supply them with a repaired field-magnet coil for £40. At a subsequent meeting on the 7th inst. the committee approved plans showing the position of the electric lamps to be erected in Western-road, North-street Quadrant, North-street, and Old-steine.

Scarborough.—The Sanitary and Lighting Committee of the Town Council having considered the question of obtaining tenders for lighting certain streets with the electric light, have resolved that the town clerk be instructed to obtain a tender from the Scarborough Electric Supply Company for lighting certain streets with the electric light. The Electric Lighting Sub-Committee have presented a report from Mr. B. Drake, who stated that in accordance with instructions he had made a personal inspection of the Scarborough lighting station, and was pleased to say that he found it in a generally satisfactory condition. He recommended that another engine and fan should be provided as duplicate to the present one, for at present, if anything happened to either the small vertical engine or fan, the ventilation would not be maintained.

Sale of Plant.—On Wednesday, February 6, Messrs. Wheatley Kirk, Price, and Goulty will sell the electric lighting plant, instruments, arc lamps, transformers, cable, stores, etc., of the Brighton and Hove Electric Light Company, Limited, at the central lighting station, 48, Gloucester-road, Brighton. The plant comprises four Lowrie-Parker alternating, one Mordey-Victoria, six series-wound, one Ferranti, one Gramme, and other dynamos; water tank and purifier; four 50-h.p. undertype engines and boilers, by Fowler; four donkey pumps, by Pearn; shafting, 60 accumulators, switchroom appliances, test instruments; 19 Brush, Brockie-Pell, Kent, and Croggan arc lamps; about 20 miles cable; 166 Lowrie-Hall, E.C.C., Goolden, etc., transformers; fuses, switches, instruments, belting, loose tools, stores, office furniture, and other effects.

Bournemouth.—The Town Council last week adopted the report of the Electric Lighting Committee. The latter reported, with reference to the Bournemouth public purposes electric lighting license granted to the Corporation, that the Board of Trade had approved the system proposed to be adopted by the Corporation. The committee also recommended that the draft contract for the electric lighting of the Winter Garden should be settled by the chairman and town clerk before being submitted to the electric supply company for approval. The committee recommended that the Bournemouth Electric Supply Company should be asked whether there had been any alteration in the constitution of the company, involving a transfer of their undertaking, and whether the consent and approval required by Section 4 of the Poole Electric Lighting Order, 1891, had been applied for and obtained.

Wolverhampton.—A meeting of the Town Council has been held, at which Alderman Owen asked when the electric light would be ready. The Mayor replied that no member of the Council was more annoyed at the state of affairs than himself. When he said that their contracts were to have been completed by September 1, and that an extension of time was given, they might reasonably suppose the electric light would have been installed long before the present time. But it was absolutely of no use for the committee to take over the works until they were satisfactorily completed. It was absolutely essential that a complete test should be made for at least a week before they took over the whole of the delicate machinery and lighted the town. Arrangements had been made for tests, but they had not been completed. If those tests were satisfactory, the town would be lighted at an early date.

Sheffield.—The directors of the Electric Light and Power Company on Monday met their customers, and explained to them the causes that have led to the recent temporary interruptions of supply, and also to state the arrangements which are being made to prevent a recurrence of such mishaps. The explanations and assurances of Alderman Franklin, the chairman of the company, who was supported by Alderman Gamble, Messrs. George Senior, W. S. Laycock, and William Tasker (directors), and Mr. William Johnson (manager and secretary), were cordially appreciated. The new electric light plant laid down by the local company comprises a Willans compound engine running at 520 revolutions per minute, and coupled direct to a Wilson-Hartnell dynamo. The engine, with 95lb. of steam, gives 39 h.p. These engines are extremely economical in coal, a consumption of 13lb. of steam per indicated horse-power having been recorded.

Direct United States Cable Company.—The report of the directors for the six months ended December 31 last states that the half-year's revenue, after deducting out-payments, amounted to £38,342, as compared with £41,051 for the corresponding period of 1893, being a decrease of £2,709. The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cable, amounted to £19,024, leaving a balance of £19,318 as the net profit, making, with £1,031 brought forward from the previous half-year, a total of £20,349. Interim dividends of 2s. per share for the quarter ended September 30 and of 2s. per share for the quarter ended December 31 have been declared, and after setting aside £3,400 pending settlement of disputed accounts with other telegraph companies and £3,000 to the reserve fund account the balance of £1,807 on the revenue account has been carried forward.

Kingston-on-Thames.—The Town Council last week adopted a report of the Lighting and Market Committee, which contained the following: That Councillor Collins be appointed chairman of the committee for the ensuing year, and that Councillor Salmon be appointed vice-chairman. Tenders were opened for the supply of materials and work to be done at the electric lighting works with regard to the new boiler, and that of Mr. H. Barrett was accepted. It was resolved that in future a minimum charge of £2. 10s. per annum be made for current supplied, and a clause to that effect inserted in the agreements. The town clerk read a letter from the Artisans' Land Company, asking the Corporation to take the necessary steps for the efficient electric lighting of the new roads made, or proposed to be made, on their estate, as shown on plan, and for the supply of electricity for lighting and cooking purposes in houses on the same estate. It was resolved that the town clerk be instructed to enquire of the company if they are prepared to pay the cost of laying down the mains and erecting arc columns in such roads.

Eastern Telegraph Company.—The directors, in their report for the six months ended September 30 last, state that the revenue for the period amounted to £362,557, from which are deducted £97,533 for the ordinary expenses and £43,709 for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing £4,815 for depreciation of spare cable, £1,138 due to revaluation of currency assets, and £5,458 for income tax, there remains a balance of £209,902, to which is added £2,001 brought from the preceding half-year, making a total available balance of £211,903. From this balance there have been paid interest on debentures and debenture stock, dividend on preference shares, and two interim dividends of 2s. 6d. per share each on the ordinary shares. After carrying £4,860 to the reserve fund for maintenance ships, there remains a balance of £59,175, which is carried forward to the next account. The revenue includes £22,687 dividends for the half-year upon the Company's shares in the Eastern and South African, the Black Sea, the Direct Spanish, and the African Direct Telegraph Companies.

Hampstead.—The Vestry last week adopted several recommendations of the Electric Lighting Committee. One was that Mr. H. W. Christmas, solicitor for Mr. R. Scarlett, of Heath-street, should be informed, in reply to his letter on the subject of the transformer-chamber recently built in the footway opposite his client's premises, that the Vestry could see no reason to offer any compensation in the matter. A second was that two partitions should be put up in the coal bunkers for the purpose of further utilising the space at an estimated cost of £5. 10s.; that a light two-wheeled hand-truck, for carrying tools and materials for house connections, be obtained at an estimated cost of £7; that the horizontal shafting over the top of the boilers be fenced in according to the requirements of the Government factory inspector at an estimated cost of £5. 10s.; and that the offer of Messrs. Radford and Co. to supply 50 tons of Derbyshire coal at 13s. per ton should be accepted. The committee appointed to inspect and approve of the fittings to be used in the installation in the Vestry Hall reported that they had inspected the fittings supplied by Messrs. Verity and Sons, and passed them as satisfactory.

Church-Lighting.—The vicar and churchwardens of St. Peter's Church, Eaton-square, are to be congratulated on their decision some time back to light St. Peter's Church by electricity, and at

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the same time to clean and recolour the interior. The electric light has now been put in, and the arrangement of the new illuminant is eminently successful. It is a feature of the scheme to utilise the reflecting power of the light colours on the surrounding surfaces in order to obtain an equal diffusion of light, and to avoid an otherwise prodigal waste of lights, whilst at the same time hiding as much as possible the actual lights from the direct vision of the congregation. The illumination of the architectural features and beautiful mosaic work in the sanctuary is particularly pleasing, as there are no lights actually seen to distract the attention or weary the eyes. When the additions and alterations to the edifice—which are in progress—are completed there will be some 260 lamps fixed, replacing some 640 gas burners previously in use. The scheme of lighting is from the designs of Mr. W. Howard Tasker, M.I.E.E., of Pembroke-road, Kensington, who prepared the plans and specification, and under whose supervision the work was carried out. Messrs. Moody Bros. secured the contract.

Mallow.—When the Town Commissioners met on Monday, Mr. Harold mentioned a matter which he considered was of utmost importance He complained, as a town commissioner and representative of the ratepayers, that the Mallow Gas Company, who traded under the appellation of the New Mallow Gas Company, were in no way better than the old. They (the Commissioners) had often made complaints against the old company, but they had double the number against the new. He (Mr. Harold) wished to have the Commissioners direct their clerk to write to the gas company on the matter. He also wished to give notice that at the Commissioners' next meeting he would bring forward a scheme for the purpose of lighting the town by electricity, and he would show that they could do it with water as a motive power. He believed the cost would be considerably less than it was at present, and they would try and form a little company for that purpose. What he wished to have the clerk write to the company was that unless they settled the matter complained of, they (the Commissioners) would form themselves into a company and light the town by electricity. After some discussion on the matter, the clerk was directed to communicate, in compliance with Mr. Harold's suggestions, with the gas company.

Newark.—The clerk to the Rural District Council read to the latter on Tuesday an application from the gas company for consent to their provisional order. In doing so, he remarked that if they put all these powers in the hands of the company they might monopolise the supply of electricity. He thought there could be no objection to the extension, but the section relating to the supply of electricity was open to objection. Alderman Hole said he was not sure that it would be wise to sanction the extension. Their Parish Council had ordered the letter to lie on the table, and they had done something of the same kind in Balderton. There was an idea that having the supply of all these places would increase the prospective value of the works. As they were aware, negotiations were going on with the Newark Corporation, and if they agreed to this extension, they virtually cut out the other side from setting up gasworks, or from arranging a supply of their own if they wished it. He thought they should stand a much better chance of being dealt with by the Corporation than of being dealt with by the present company. The Parliamentary Committee of the County Council met a few days ago, and they were going to oppose it, and it would be safe for them to do the same. He proposed that they object to give their consent to the provisional order. Mr. Whitaker seconded the proposition, which was agreed to.

Anglo-American Telegraph Company.—The report of the directors for the past half-year states that the total receipts from July 1 to December 31, 1894, including the balance of £1,173 brought forward from the last account, amounted to £148,837. This sum, however, is subject to revision, as the financial result of the judgment given in favour of this Company against the Paris and New York Telegraph Company cannot yet be determined. The traffic receipts show a decrease of £6,948 as compared with the corresponding period of last year. The total expenses of the half-year, including the repair of cables, etc., as shown by the revenue account, amounted to £55,851, being a decrease of £3,399. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £80 985. Interim quarterly dividends of 9s. per cent. on the ordinary stock and 18s. per cent. on the preferred stock were paid on November 1 last, leaving a balance of £49,485, out of which the directors recommend the proprietors to declare final dividends of 14s. per cent on the ordinary stock and £1. 8s. per cent. on the preferred stock, making a total distribution for the year of £2. 2s. per cent. on the ordinary stock and £4 4s. per cent. on the preferred stock, leaving £485 to be carried forward to the next account.

Morecambe.—The annual meeting of the ratepayers of the Sandylands division of the parish of Heysham was held recently at the Cumberland View Hotel, for the purpose of transacting ordinary business and considering the proposed electric lighting question of the Sandylands district. The inspectors' report was read as follows: "When the ratepayers at our meetings a few months ago decided to adopt the electric light for public lighting of the Sandylands district of the parish of Heysham it was stated that the business was practically accomplished. We, your inspectors, regret to have to report that subsequent events have proved that it was not so. Your inspectors made a contract with the Morecambe Electric Light and Power Company according to which you were to have had the light on March 5. You all know that, although the lamps have been erected by the company, we have had no electric light, yet your inspectors and late secretary did everything that could be done to induce the company to complete the contract. They have had a great number of meetings and many interviews with various persons and a voluminous correspondence and law proceedings without the desired result. We cannot discuss the case in public meeting until after judgment, but our solicitor and counsel are of opinion that we have a good case. We, however, suggest that you appoint six of your number to confer with us respecting the matter. We expect to have public lighting in a few weeks now." Some ratepayers were elected to confer with the inspectors respecting the action pending against the Morecambe Electric Light and Power Company for alleged breach of agreement to supply the Sandylands district with electric light. After some discussion it was decided to adjourn the meeting until some future date, when the inspectors and the above-appointed gentlemen would report on their negotiations with the electric light company.

Bath.—The Town Council last week discussed at some length the present position of electric lighting in the town. Alderman Sturges, chairman of the Lighting Committee, moved a resolution that the application of the electric light company for a provisional order should not be consented to, but that the authority apply to the Board of Trade for an order. He explained that the committee had consulted Mr. Medhurst. There was a large meeting of 15 or 20 members of the committee present, and they were quite unanimous in their opinion that it would be advisable to take the step they proposed. The advice given them by Mr. Medhurst was to this effect: "It's no use for you to rest upon saying that you do not wish them to obtain a provisional order The Board of Trade will say you must allow either the company to obtain it or obtain it yourselves; you must not act the part of the dog in the manger, that you can't do it yourselves and won't let anybody else do it." The Council must either go backwards or forwards. He had previously pointed out that the company had a license for seven years, and only four had elapsed, but Mr. Medhurst said the Board of Trade would not look at that as sufficient reason for refusing the provisional order, although they might think it very strange for the company to apply now. With regard to their application for a provisional order, Alderman Sturges pointed out that the Board of Trade naturally leaned to the authority, and quoted a similar case in which the authority were granted the provisional order and the company afterwards went to them and gave them a bonus of £300 for it. He hoped they would not allow the company to take the place which they themselves ought to occupy. It was for them as an authority to set themselves against great monopolies. The gas company was a great monopoly, and there was no doubt about it, if they were the owners of the gasworks the rates of the city would be lighter. There was a general public feeling in favour of these things being in the hands of the Corporation. What was to follow after they had obtained the provisional order was, of course, a thing to be decided upon later. They might either work the station themselves or lease to the company and get a bonus that would be remunerative to the public. Mr. Stone formally seconded the resolution, which after some discussion was adopted.

Messrs. Felten and Guilleaume.—This firm, of Carlswerk, Mulheim-on-Rhine, who are represented in this country by Messrs. W. F. Dennis and Co., of 11, Billiter-street, E.C., have been very busy during the past year in their cable factory, and have supplied high and low pressure cables for numerous electric light central stations, as well as for electric tramways. Among these may be mentioned for Frankfort-on-the-Maine, Hamburg, Pforzheim, Sigmaringen, Neustadt on-the-Haardt, Donauschingen, Salzungen, Liège, Saragossa, and Madrid, the total length amounting to about 400 miles. Besides the above, the firm have secured the following contracts for supply of the cables for Dresden, Stuttgart, Munich, Frankfort-on-the-Maine, Hamburg, Ulm, Aix-la-Chapelle, in all about 600 miles. Apart from electric light cables, Messrs. Felten and Guilleaume have again been favoured by the Imperial German Post Office with numerous contracts, amounting to several hundred miles, for telegraph and telephone cables, and have laid a new telegraph cable to the Isle of Borkum, consisting of about 20 miles underground and the same length of submarine cable. The firm have during the past year continued to make strenuous efforts towards the adoption of their paper and air-space telephone cables which, wherever supplied, have been highly appreciated. Some of the great advantages are their high insulation resistance and low capacity, no other cable, it is claimed, yielding such a low capacity. The same system is also being advantageously used for telegraph and electric light cables. The firm's bronze wires, especially the double bronze wire, meet everywhere with the greatest satisfaction, and they have withstood frequent snowstorms better than any other material hitherto used, the lines having hardly been damaged at all. The bronze wire as well as paper and air-space telephone cable are used for the telephone line from Madrid to Barcelona. In addition to the many articles made by Messrs. Felten and Guilleaume, they have now taken up the manufacture of the so-called "Salamander wire," the first and only strictly fireproof-insulated wire produced. The covering of this wire, it is stated, will not burn when exposed to a flame, and the conductor can be heated to the melting point without igniting the insulation. The rope factory has also been very busy with orders for ropes of ordinary construction for all purposes. Their locked coil ropes are also gaining the favour of interested circles more and more in consequence of the better results they have given over ordinary types. Another towing-rope of about 20 miles, in one length, has also been supplied for the Rhine. The firm's Antwerp exhibits have been awarded four grand prizes.

Edison and Swan United.—An extraordinary general meeting of the Edison and Swan United Electric Light Company will be

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held at the Cannon-street Hotel on Tuesday, February 5, at half-past twelve o'clock, to consider and, if approved, to pass the following resolutions, which, if passed, will be submitted to a subsequent general meeting for confirmation as special resolutions: That article 10 be repealed, and the following article substituted: "10. The instrument of transfer of any share in the Company shall be on the usual common form, under seal, and be executed both by the transferor and transferee, and the transferor shall be deemed to remain the holder of such share until the name of the transferee is entered in the register book in respect thereof." That the words "or stock" be omitted from article 11. That the following words be inserted at the end of article 16: "And that no call shall exceed one-fourth the nominal amount of a share, nor be made payable within two months after the last preceding call was payable." That in article 20 the words "not fully paid up" be inserted after the word "shares." That article 41 be repealed, and the following articles substituted therefor: "41. Seven days' notice of any general meeting (exclusive both of the day on which the notice is served or deemed to be served, and of the day of the meeting) specifying the day, hour, and place of the meeting shall be given to the members in manner hereinafter mentioned, or in such other manner as may from time to time be prescribed by the Company in general meeting, but the non-receipt of such notice by any member shall not invalidate the proceedings at any general meeting." "41a. The notice convening an ordinary general meeting shall state the general nature of any business intended to be transacted thereat, other than declaring dividends, electing directors and auditors, and voting their remuneration and considering the accounts presented by the Board, and the reports of the Board and the auditors. The notice convening an extraordinary general meeting shall state the general nature of the business intended to be transacted thereat." That article 59 be repealed, and the following article substituted: "The qualification of a director shall be the holding, in his own right, of not less than 200 A or B shares. A first director may act before acquiring his qualification, but shall in any case acquire the same within one month from his appointment, and unless he shall do so he shall be deemed to have agreed to take the said shares from the Company, and the same shall be forthwith allotted to him accordingly." That in article 65, clause (*c*) the words "or in loans upon the security of" be inserted before the words "its own shares." That the following words be inserted at the end of clause (*f*) of the same article: "Provided that without the sanction of a general meeting the Board shall not raise or borrow any sum of money which will make the amount raised or borrowed and then outstanding exceed £200,000." That the following words be added at the end of article 94: "And a copy of such balance-sheet and account shall be sent seven days before the general meeting to each member entitled to the same."

Messrs. Drake and Gorham.—During the past year this well-known firm have made considerable progress, work having been carried out by the firm or partners for the following clients: the Duke of Devonshire; Lord Houghton; Army and Navy Stores; Lord Gosford; Scarborough Corporation town-lighting; Earl Derby; Marquis of Londonderry; Baron Schröder; Baron de Knoop; Sir Frank Lockwood; Duchess of Montrose; Lady Wynne; Greenway House, for Mr. T. B. Bolitho, M.P.; The Lodge, for Mr. Felix T. Cobbold; Mr. Victor Cavendish; Lady Sitwell; The Manor House, for Mr. H. T. Alton; Etherington Hill, for Mr. E. Janson; LeCourt, for Mr. Heath Harrison; The Priory, Rugeley; Sutton House, for Mr. Andrew Jameson; Abney Hall, for Mr. Watts; Testwood, for Captain Beaumont; Sir Gervas Glyn, Ewell; Mr. J. T. Smithes, Eveley; Mr. R. Clifford Smith, Ashford Hall; Mr. T. Howland, Amersham; Right Hon. C. T. Ritchie, The Welders; Mr. C. Behrens, Holmacre; Mr. B. Pennington, Sydenham; Mr. V H. Nevill, Bramall Hall; Dr. Venn, Kemnal Wood; Mrs. Torrens, Eaton-square; Royal Geographical Society; University Galleries; St. George's Hospital (further extensions); Balliol College; Messrs. David Allen and Sons, printing works; the Manchester, Sheffield, and Lincolnshire Railway, London offices; the *Morning* offices; City of London College; borough of Richmond main sewerage works; Buenos Ayres and Rosario Railway Company; Exploration Company; Mr. G. S. Harris; Mrs. Barbara Allen; Sir Vincent Barrington; Dr. Anderson (extensions); Mr. Pearse Gould; and Mrs. Ewart. The same progress is recorded at the Manchester and Scarborough branches, of which the following instances may be given: Lancashire Assurance Company; Brook's Estate; Haworth's Buildings; Mudie's Library; Adelphi Bank; Barton-arcade; Bridgwater Trustees; Muirhead and Sons (arc and incandescent lamps); Darbishire, Tatham, and Worthington; the Sun Fire Offices; Consolidated Bank; Brook's Bank, Blackburn; further extensions at Colonel Steble's; Masonic Hall; Sarony and Co.; Mr. J. Woodall; Dr. Dale; Dr. Horn; the Spa Theatre; and Mr. H. A. Johnson. The number of lights put in during the year equals about 40,000 of 8 c.p. The D.P. battery introduced some six years ago is steadily gaining in popularity, as contractors have found after trial that there are many advantages in their use, and the consequence is an enormous increase in the sale during the year. Hundreds of batteries are now in use all over the country, and many can be seen in daily work which have lasted for six years without repairs, and appear as good as new. Spring contact switches command a large sale in the trade, and most of the important manufacturers have taken a license for this type of switch. The earthing device has been supplied in large quantities to supply companies, and no case has yet occurred where it has failed to effect its purpose. There are now over 2,400 of these in daily use. The Cardew voltmeter has been remodelled by Major Holden, and a recording instrument made on these lines is rapidly growing in favour among central-station engineers.

Newcastle Tramways.—The Town Council last week discussed the report of the Parliamentary and By-Laws Committee with regard to the North-Eastern Railway Bill, 1895, and the Newcastle Tramways Provisional Order, 1895. The report with regard to the Railway Bill said it was proposed to widen on the south side the bridge which carries the company's line over the Forth Banks. The committee saw no objection to the Bill. With regard to the draft Tramways Provisional Order, the committee reported as follows: "That there be added to Clause 5 'or by any other mechanical power which may be sanctioned by the Board of Trade'; that Clause 6 be altered so as to read, "All Acts of Parliament and all by laws and regulations made by or with the approval of the Board of Trade for the time being in force relating to the use of steam or mechanical power upon the said tramways shall, so far as they are applicable for the purpose, extend and apply to the use on such tramways of the motive power by this order authorised'; that there be added to Clause 9, 'The repayment of all moneys borrowed under the provisions of this order shall be effected by equal yearly or half-yearly instalments of principal or of principal and interest." The report, so far as concerned the North-Eastern Railway Bill, was agreed to. With regard to the cable trams, Alderman Richardson wanted to know if, in his communication to the Council, Mr. Eustace Smith, as representing the newly-formed tramway company, had undertaken with the Corporation to adopt any other system, be it electrical or any other system, that could be worked in the future as efficiently and as cheaply as the cable system, as to the remainder of the tramways. The Town Clerk having read the letter from the lessees bearing on this subject, Alderman Richardson said he took it that the guarantee of Mr. Eustace Smith meant that the proposal of the lessees at present was to work the cable system upon the Westgate, Scotswood, and Byker routes for five years. The Town Clerk did not think their proposal meant anything of the kind. The lessees asked for those lines to be converted to cable lines, and asked for a lease of 21 years from the expiration of the present lease, which was really 26 years from now. The lessees then said the remainder of the present lines should be continued as horse lines for a period of, say, three years from the opening of the new cable lines. They asked that the cable lines be put down within two years. Then they said that, within three years from the beginning of the cable system, the Corporation should apply to them any form of mechanical traction approved by them as being as economical per car mile as the cable system in this city. They wanted the Corporation within three years of the opening of the cable lines on the Scotswood, Westgate, and Byker lines, to adopt some kind of mechanical traction approved by them for the remainder of the lines. In reply to a question, the Town Clerk said he thought "approved by them" meant by the Corporation. Alderman Hamond moved, "That this provisional order be not proceeded with in the ensuing Parliament." There was a letter, he said, sent to the Town Improvement Committee on the subject of the tramways from a firm at Chester. No report had been presented by the committee to the Council on that offer, although he understood that the firm was prepared to lay down a line and try the electric system in the city at their own expense. The Town Improvement Committee had treated the offer with contempt; they were afraid of the result, or they were indifferent to the interests of the public On this ground alone he was justified in making this proposition. Mr. Goolden seconded the motion, which was ultimately rejected, and the report was adopted.

Aberdeen and Telephony.—The Finance Committee reported to the Aberdeen Town Council on Monday that a letter had been submitted from the town clerk of Glasgow transmitting copy of a memorandum recently addressed by the Corporation of Glasgow to the Postmaster-General with reference to the agreements which the Postmaster-General proposes to enter into with the National Telephone Company, Limited, and the New Telephone Company, Limited. In their memorandum it was suggested that the Government should assume the working of the telephone system in the same way as the telegraph, and that if Government is not prepared to do so municipal authorities should, when they so desire, receive a license to undertake the telephonic service within the areas under their charge. If, however, agreements are to be made by Government with the telephone companies, the Glasgow Corporation submitted that due provision should be made for safeguarding the rights of municipal authorities as regards interference with streets and similar matters, and also for the protection of the public with reference to obligation as to supply, maximum charges, and maximum dividends. The committee recommended (*a*) that the Town Council should co-operate with the Corporation of Glasgow in pressing upon the Postmaster-General the views above indicated; and (*b*) that in the event of the Postmaster-General consenting to receive a deputation, in accordance with the request which has been made to him, the convener should be authorised to represent the Town Council. Treasurer Bisset, in moving the adoption of the recommendation, said the object of the Finance Committee was to assist other municipal corporations in their endeavour to get a more satisfactory settlement of the question with regard to the telephonic service. At present there was an agreement lying on the table of Parliament as to arrangements proposed to be entered into between the Postmaster-General and the National Telephone Company. Hitherto, the National Telephone Company had not had any legal standing in any district. They existed on suffrage, and the Town Council could put a stop to their operations if they cared to do so by simply refusing to allow them to cross the streets with their wires. The system of carrying the wires overhead was very unsatisfactory, and was objected to on many grounds. A Select Committee of the House of Lords had reported that it

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should not be allowed to continue, and that any new license would be given only on condition that the wires were put underground. With a view to enabling the telephone company to carry out the recommendation of the committee, the Postmaster-General, in the agreement referred to, asked Parliament to confer upon the telephone company the power of entering streets and other property belonging to the different corporations and private bodies for the purpose of carrying on their operations. The treasurer was perfectly satisfied that they could not at this time of day allow such a thing to be done by a private company which was not subject to public control. The capital of the telephone company was close upon £5,000,000, and a very large proportion of that had been spent in buying up other companies and in buying up patents that had now expired, and were therefore of no value. The actual value of the property did not exceed £1,000,000. He spoke in favour of municipalities being granted a license to carry on the system, and pointed out that were something not done they would have to go on paying interest on five times the actual value of the property owned by the present company There were two alternatives. They might join with other municipalities in doing something to put an end to this thing, or they could allow the public to be fleeced as they had been fleeced in the past by paying heavily for a very inefficient service. A very efficient service could be given to the public for one-half of what they were at present paying. So far as they were concerned, in the meantime they had simply to agree to back up the other municipalities in their effort in the interests of the public, and they were perfectly satisfied the public could get a much better service than at present at a much lower cost. Bailie Edwards seconded the motion, which, after some discussion, was adopted.

PROVISIONAL PATENTS, 1895.

JANUARY 14.

856. **Improvements in telephonic transmitters.** John Harry Salter, 70, Chancery-lane, London.

867. **An improved electricity meter for registering the amount of current consumed on direct or alternating polyphase, triphase, or quadruplephase circuits.** Frederick John Beaumont and Frederick Hallows, 166, Fleet-street, London.

883. **Production of liquid ammonia by electricity.** Richard William Hill, 97, Newgate street, London.

884. **An electric alarm and detector of oxygen gas.** Richard William Hill, 97, Newgate-street, London.

890. **An electrical ballet.** Adolph Cannot, trading as A. H. Chamberlyn, 175, Strand, London.

JANUARY 15.

962. **Improvements in and relating to electric railways and apparatus therefor.** Carl Friedrich Philipp Stendebach, 18, Buckingham-street, Strand, London.

1000. **Improvements in and relating to conduit electric railways.** William Tasker Dulany, jun., and Oscar Fisher Shaw, 77, Chancery-lane, London. (Complete specification.)

1012. **An improved electrical device for lighting and extinguishing incandescent gas lamps.** William Phillips Thompson, 31, High Holborn, London. (Julius Bilfinger, Germany) (Complete specification)

JANUARY 16.

1085. **Improvements in electrical apparatus for lighting and extinguishing gas burners.** Axel Orling and Oscar Ehrenfried Wollert, 4, South-street, Finsbury, London.

1088. **An improvement in safety fuses for high-tension electric currents.** Siemens Bros. and Co., Limited, and Francis Hird, 28, Southampton buildings, Chancery-lane, London. (Complete specification.)

JANUARY 17.

1116. **Improvements connected with boats and vessels propelled by electricity.** Robert McLauchlan McDonald and Alexander McDonald, 70, Wellington-street, Glasgow.

1117. **Improvements in electric batteries.** Robert McLauchlan McDonald and Alexander McDonald, 70, Wellington-street, Glasgow.

1120. **Improvements in telephone circuits and apparatus appertaining thereto.** August Eckstein and Richard Pentney Eidsforth, 45, Chapel-street, Salford, Manchester.

JANUARY 18.

1180. **Improvements in solutions for use in primary batteries.** Hymen Levetus, Edward Moses Levetus, Walter Rowbotham, and Charles Levetus, 47, Vittoria-street, Birmingham.

1181. **Improvements in solutions for use in primary batteries.** Hymen Levetus, Edward Moses Levetus, Walter Rowbotham, and Charles Levetus, 47, Vittoria-street, Birmingham.

1202. **Improvements in telephonic apparatus.** William Edward Langdon, Midland Railway, Derby.

1206. **Apparatus for measuring and recording electrical currents.** John Friends and Thomas John Murday, 20, King-street, South Shields.

1234. **Method of varying the speed of multipolar electric motors.** John Augustus Essberger, 46, Lincoln's-inn-fields, London

1260. **Self-inductor current alternators.** Paul Boucherot, 60, Queen Victoria-street, London.

1262. **Improvements in electric arc lamps.** William James Davy, 40, Chancery-lane, London.

JANUARY 19.

1279. **An automatic resistance coil for the regulation of electric currents.** Samuel Sealy Allen, 52, Woodstock-road, Bedford Park, London.

1317. **Improvements relating to electric lamps.** Robert Hacking and George Brand, 78, Fleet-street, London.

1318. **Improvements in armatures for dynamo-electric machines.** Rookes Evelyn Bell Crompton, Sydney Linton Brunton, and Percy Privett, 55, Chancery-lane, London.

1353. **Improvements in the application of telephones to electric bell systems.** Frederick Hodgson and George Alfred Edwards, 8, Agincourt-road, Hampstead, London.

SPECIFICATIONS PUBLISHED.

1881.

4409. **Telegraph conductors, etc.** Callender. (Second edition.

1893.

25009. **Electric cigar lighters.** Schindler.

1894.

191. **Dynamos.** Keith.

192. **Electric drills, etc.** Keith.

4113. **Electric batteries.** Barnett.

4190. **Electrically illuminated signs, etc.** Berry and Harrison.

4540. **Overhead conductors of railways and tramways.** Siemens Bros. and Co. (Siemens and Halske.)

5340. **Electrical resistance coils.** Fleming.

5592. **Counterweights for electric light pendants, etc.** Grubb and Sturgf.

21098. **Obtaining electrical energy from fuel gases.** Borchers.

22821. **Conduits for electrical conductors.** Tatham.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅝-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ Debenture Stock	100	111-114
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	15½-15⅝
—— 5 per cent. Debenture Stock	115	132-135
City and South London Railway, Consolidated Ordinary	100	44-46
—— 4 per cent. Debenture Stock	100	127-129
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	3-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	102-107
Electric Construction, Limited	2	½-⅝
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1½-1⅝
Elmore's French Company	2	1/16-3/16
Elmore's Wire Company	2	½-1½
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	9-10
—— Preference	—	12
House-to-House Company, Ordinary	5	2½-2⅝
—— 7 per cent. Preference	5	6½-7
India Rubber and Gutta Percha Works	10	25½-26½
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	—	7-7½
Liverpool Electric Supply, Ordinary	5	7½-7⅝
—— Pref.	—	—
Liverpool Overhead Railway	10	8½-8⅝
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	½-⅝
Metropolitan Electric Supply	10	9⅜-10½
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	5½-5⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅞-6½
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7-7½
Oriental and Electric Company, £1 shares	1	11/16
—— £5 Shares	—	7-7½
—— £4½ shares	—	5⅜-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅜-8½
—— 7 per cent. Pref.	5	8⅜-9½
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7½-8
Yorkshire House-to-House	4½	4¼-4⅜

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NOTES.

Lecture.—A lecture on "Magnets and Electric Currents" has been delivered by Prof. J. A. Fleming at Peterborough.

Obituary.—The death has just occurred of Mr. T. Bird, manager of the works of the General Electrolytic Company, at Farnworth.

Ship-Lighting.—The "Majestic," which was to be floated yesterday at Portsmouth, is lighted electrically, and is equipped with search-lights.

Australia.—The inhabitants of Adelaide have been polled to decide whether the city should be lighted by gas or electricity. The result of the polling was in favour of gas.

Acton Tramways.—A report of an interview with Mr. J. Clifton Robinson, the promoter of the proposed Acton electric tramway, was published in *London* of the 24th ult.

Institution of Civil Engineers.—On Tuesday next, at 8 p.m., a paper will be read on "The Mechanical and Electrical Regulation of Steam-engines," by Mr. John Richardson, M.I.C.E., of Lincoln.

Transmission of Power in Italy.—A scheme for the utilisation of the hydraulic power of the Naviglio Grande, to the extent of 18,600 h.p., has been advanced by Messrs. G. B. Conti and L. Greppi

Telephony in Germany.—A telephone exchange with 32 subscribers has been opened at Landshut, Bavaria. It is connected with the long-distance telephone system of Bavaria on the right bank of the Rhine.

Telephony.—The National Telephone Company are developing their system in Kent. During the past week Tunbridge Wells and the intermediate towns of Tonbridge, Hadlow, Wateringbury, Yalding, and other places have been telephonically connected with Maidstone.

Royalty and Electric Traction.—An electric tramway is in course of construction at Nice, and is expected to be completed by March 1. This line will be used by her Majesty the Queen, who is expected to arrive at the Hotel Cimiez on the 15th of that month.

Society of Arts.—On Tuesday next, at 8 p.m., a paper by Mr. Gleeson White will be read on "Drawing for Process Reproduction." On Wednesday, at 8 p.m., a paper by Mr. Geoffrey Drage will be presented on "The Labour Question in the Colonies and Foreign Countries."

Students of the Institution.—A students' meeting of the Institution of Electrical Engineers will be held in the library of the Institution, 28, Victoria-street, on Friday next, 8th inst., at 8 p.m. A paper on the following subject will be read: "The Magnetic Condition of Matter" (with experiments), by Mr. Chas. E. S. Phillips.

Society of Engineers.—The first ordinary meeting of this society for this year will be held on Monday next at the Westminster Palace Hotel, commencing at 7.30. Sir Robert Rawlinson, K.C.B., hon. member, will present the premiums awarded for papers read during last year, and the president, Mr. W. G. Peirce, will deliver his inaugural address.

"Our London Letter."—The "London letter" of the *Indian Engineer* of January 5 contains a paragraph reproduced from our columns concerning an electric piano. It is a pity that the "writer" of the "London letter" does not know that it is "righter" to acknowledge an editorial comment than to cut it out from a contemporary and print it as his own.

Fire.—We regret to learn that a fire occurred on Wednesday at the Bournbrook depôt belonging to the electric car section of the Birmingham Central Tramways Company. The battery-room was burned down, and as a result the service of cars had to be suspended and omnibuses used instead. It is expected that the service will be resumed in a few days.

Gas Journals, Please Copy.—Will the gas journals which are so fond of decrying the electric light reprint the following: On Tuesday afternoon, while the gas-mains were being repaired in Gidling-street, Dockhead, Bermondsey, an explosion occurred. An elderly lady and a boy were injured, and considerable damage was done to the surrounding property.

Carbonne.—At this town, in the department Haute-Garonne, an electric lighting scheme has been carefully drawn up and approved. The total outlay will not exceed £3,000, which sum will be borrowed and repaid in 30 years by annuities of £160 each. Of these the communal funds take half, leaving the rest for private subscription. Water power is to be used

Railway Rates.—Members of the London Chamber of Commerce are reminded by the council of previous circulars recommending them to lodge complaints with the Board of Trade, not later than February 25, of any increases of railway rates within their own experience which are of such an unreasonable character as to justify resistance to the demands of the railway companies.

Merchandise Marks.—In view of the early opening of the new session of Parliament, and with the object of ascertaining the present drift of commercial opinion on the subject of the Merchandise Marks Acts and their operation, the council of the London Chamber of Commerce have decided to hold a conference of members in the council-room of the Chamber on Wednesday, March 6, at 2.30 p.m.

Dock-Lighting.—A new dry dock, said to be the largest in the United Kingdom, has been opened by the Wallsend Slipway and Engineering Company at Wallsend-on-Tyne. There is an installation of electric lamps to facilitate the carrying out of repairs at night, and to enable the firm to undertake the work of repairing and refitting vessels constructed for carrying oil in bulk.

Exhibition of Agricultural Machinery.—An international mart of agricultural machinery will be held in Vienna from 4th to 7th May next. Mr. F. Stockinger, (the Austro-Hungarian Consul-General), of 11, Queen Victoria-street, E.C., who will give further information on the subject, states that the exhibition will include electrical machinery such as would be used in forestry, sawmills, celluloid factories, etc.

Electric Light Tariff.—At Soissons, a French town in the Aisne department, a commission nominated by the Municipal Council decided at its last meeting to appoint two experts for examination of and report upon the tariff of charges drawn up for the proposed electric light supply. One expert will be appointed to deal with legal and administrative points, the other, an electrical engineer, is to advise on technical matters.

Dangers of Coal Gas.—According to the annual report of Captain Simonds, no less than 284 fires were caused last year in the Metropolis by what are termed gas explosions; but not a single conflagration has been traced to the use of the electric light. This fact will be a trifle of a "choker" for that gassy paper, the *Journal of Gas Lighting*, but one cannot expect the latter to have the candour to admit the truth of this statement.

State Telegraphy.—One of the *Daily Chronicle's* young men has endeavoured to interview Mr. W. H.

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Preece on the subject of the twenty-fifth anniversary of the transfer of the telegraphic system to the State. As might have been expected, the fascination of the *Chron.* was not sufficient for Mr. Preece, and he therefore asked Mr. James Hookey to dispose of the young man. He did so, and the young man soon took his "hookey."

Cable Rates to South Africa.—It is stated that, contrary to general expectation, the negotiations between representatives of the South African Powers and the cable companies for the reduction of the cable rates between London and South Africa have resulted in a deadlock. Hitches have occurred, one of which is the refusal of President Kruger to agree to pay the amount of subsidy desired. The negotiations are therefore indefinitely postponed.

Yachting Exhibition.—A yachting exhibition was opened at the Royal Aquarium, Westminster, on Tuesday. Mechanically-propelled craft are numerous, and include launches driven by steam, oil, naphtha, and electricity, and Daimler motor-boats. Amongst other exhibitors in this section may be mentioned the British Aluminium Company, Westminster; Thames Electric Launch Company, Twickenham; Mr. S. S. Saunders, Goring; and the Liquid Fuel Engineering Company, East Cowes.

Battersea Polytechnic.—The Battersea Polytechnic, which was opened early last year, appears to have been educationally a great success. People are beginning to find out the advantages it has to offer for what are merely nominal payments, and it shows this year a general average increase throughout all the classes of about 35 per cent. In some classes the increase is but small, but in others, such as electrical engineering, there has been an advance of over 100 per cent. Science and technical classes have generally increased about 80 per cent.

International Telegraph Conference.—At the meeting of the international telegraph conference held in Paris in 1890, it was decided that an official vocabulary should be prepared by the International Telegraph Office at Berne, the employment of the vocabulary becoming obligatory for European, but not extra-European, telegrams in code, after the expiration of three years from the date of its publication. The volume has now been issued, and it will therefore come into obligatory use in January, 1898, for all code telegrams transmitted between European countries. The next meeting of the international telegraph conference will be held in 1896.

Bordeaux Exhibition.—The limit of time up to which applications for space may be lodged with the Société Philomathique de Bordeaux or the secretary of the London Chamber of Commerce has been extended to February 28. The exhibition opens in the beginning of next May and closes in the following November. The society are also particularly anxious to have a representative display from the British electrical industry. Firms which take an interest in this exhibition should put themselves in communication at once with the secretary of the London Chamber of Commerce, Botolph House, Eastcheap, E.C., or with the Société Philomathique de Bordeaux.

"Electric Power."—*Electric Power*, now in its seventh year, makes its bow to the public for January in an entirely new form and dress. It will henceforth appear as a magazine both as to size and character—a change which the readers of electrical science will greatly appreciate. The first number of the new form is handsomely printed, and contains many excellent illustrations. The reading matter is less technical in its nature, and is interesting to those who wish to know something of what is going on in electricity, and yet do not care to make a study of the science. Electricity is being applied so universally now that every progressive person should read *Electric Power*.

Electric Lighting in France.—The electric light will probably be introduced at Chamounix by next summer.—The Compagnie Urbaine have obtained a 27 years' concession for the electric lighting of Domfront, Orne.—An agreement has been come to between Mr. Honore Guiol, of Trans, and the Municipality of Draguignan for the erection by the former of a central electric light station in the town. The station will be installed at Trans, on the Arluby, an effluent of the Argeus, and will be worked by two turbines. There will also be a reserve in a steam-engine of at least 100 h.p.

Meter Prizes.—The Elihu Thomson electrical energy meter having obtained at the meter competition organised by the city of Paris a first prize of £200, Prof. Elihu Thomson devoted this sum to facilitate the study of certain theoretical questions of great interest, and a committee of French scientists was appointed to examine and report upon the dissertations sent in. The prize has just been awarded to an American scientist, Dr. A. Webster, but on account of another paper being of almost equal merit Prof. Elihu Thomson and others have contributed to offer an equal sum of £200 for the latter paper, the authors of which are Prof. Oliver Lodge, F.R.S, of Liverpool, and Mr. R. T. Glazebrook, F.R.S., of Cambridge.

Laying of New Mains.—The Westminster Electric Supply Corporation intend to lay mains and to construct street boxes in Clarges-street from Lambeth-mews to Curzon-street. The House-to-House Electric Light Company propose to lay mains in Redcliffe-square, and to place mains and construct street boxes in Cromwell-crescent. The Charing Cross and Strand Electricity Supply Corporation are about to lay mains and to construct street boxes in Buckingham-street and Duke-street. The County of London and Brush Provincial Electric Lighting Company having asked the County Council to accept four days notice instead of one month with reference to the laying of service lines from distributing mains already placed under ground, the Council have decided to accept such notice.

"Journal" of the Institution.—The current issue of the *Journal* of the Institution of Electrical Engineers contains the following papers: "Notes on Electric Tramways in the United States and Canada," by Mr. H. D. Wilkinson, member (supplementary paper); "Electric Traction, with Special Reference to the Installation of Elevated Conductors," by Mr. Robert W. Blackwell, foreign member, and Mr. Phillip Dawson, associate; and "Electrical Steep-Grade Traction in Europe," by Mr. C. S. du Riche Preller, Ph.D., member; and a full report of the discussion on all three papers. It also contains a communication from Mr. P. V. Luke, C.I.E. (director of the Construction Branch, Indian Government Telegraphs), descriptive of an interesting case of lightning on the telegraph line between Bombay and Bhusavat.

Jungfrau Railway.—One of the Swiss newspapers makes merry in a good-humoured way over the proposal to build a railway up the Jungfrau. "This is no question," it says, "of compressed air. Electricity will afford the means of traction. The tunnels will be lighted by it; there will be stopping places at all the principal glaciers, and two miles up will be seen the notice 'The Eiger Station—ten minutes to wait!' A natural glacier will be provided alongside the railway, and the train then passing round the huge mass of the Eiger will draw up at a plateau that is only clear of snow in the summer. Seven and a half miles at £40,000 a mile! That is what this project is to cost. Twenty years ago it would have been considered a chapter

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out of one of Jules Verne's books. To-day the men of money who were afraid to give half-a-crown for one of Verne's books are willing to advance nearly half-a-million for the work."

Electricity in Metallurgical Operations.—The twenty-second annual dinner of the old students of the Royal School of Mines took place last week at the Criterion Restaurant, under the presidency of Mr. W. H. Greenwood. The chairman, in proposing the toast of "The Mining and Metallurgical Industries," reviewed the history of those industries during the past year. The toast was acknowledged by Prof. Roberts-Austen, who said that they were told that the age of steam was giving way to the age of electricity, and, as regarded the metallurgical industries, that was no doubt as true as it was in the case of other industries. He saw nothing to regret in that. The modern dynamo was the direct outcome of the work of Faraday, and Englishmen had taken a leading part in the construction of the great installation which was to make the Niagara Falls available as a source of power on the other side of the Atlantic.

Madrid.—It is stated in a recent issue of *El Correo*, one of the leading Madrid newspapers, that a meeting (very largely attended) of consumers on the circuits of the electric light supply company La Madrilene was held lately to appoint a deputation which should wait upon the manager of the company to lay before him the following demands: (1) payment of damages for the serious losses and inconvenience caused to so many by reason of the failure in supply for several days past; (2) promises of more constant supply in the future, coupled with a lower charge for meters; (3) a reduction of 10 per cent. on the tariff charges. The manager was at first naturally averse to falling in with these requirements, but after consulting with his board of directors in London *(sic!)* he was instructed to comply with all the demands thus made, with additional benefits as regards installation charges and cost of lamps.

Electricity in Mining Operations.—The Austrian papers are devoting space to descriptions of an installation for the electrical transmission of energy at the Tommen pits, near Fünfkirchen, Hungary. The Danube Steam Navigation Company own the pit, from which extraction had been suspended for some time. The *Colliery Guardian* states that when it became a question of exhausting the water which had accumulated and of starting coal-getting, it was decided, on economical grounds, to have recourse to electricity. For this purpose an engine, which was not used in the mine, was fitted up to drive a dynamo giving 80 amperes at 150 volts. The current was either transmitted to a motor placed at the bottom of the shaft at a distance of 227m., where the motor actuated a pump, or to a motor placed on the surface, 56m. distant, and capable of developing 12 h.p. The installation, which has not yet had any stoppages, was set to work on March 14, 1893.

"Dangers of Electric Currents."—Mr. Edward Evans-Lloyd wrote to the *Times* from Bordeaux on the 25th ult. as follows: "It is hardly necessary to insist on the dangers incident to electric currents, but having been a witness of the fatal results of a careless manipulation of the machinery in connection with the electric tramway here, I venture to send you a short account of what happened in Bordeaux yesterday afternoon. It seems that the telephone wires run overhead parallel with those of the tramway, and that during certain repairs to the former wires they broke, and in their fall became entangled with a horse which was drawing a carriage in one direction, and with another horse in a cart going in the opposite course. The result was that both horses were killed instantaneously, as well as four unfortunate dogs happening at the same moment to be in the street. The driver of the carriage received an alarming shock, and was for some minutes riveted to his seat, though after a time he recovered."

Chloride Storage Batteries.—In our last issue we were able to announce the termination of the dispute which had arisen in connection with the chloride storage battery, and now the company working this battery in this country have brought out an illustrated catalogue pointing out the various uses to which this type of cell can be put. We have so often referred to the chloride battery that it will now be unnecessary to refer to its great advantages for lighting and traction purposes. The battery, which is made by the Chloride Electrical Storage Syndicate, Limited, of 16, Victoria-street, S.W., is also supplied by the Electric Storage Battery Company, of Philadelphia, U.S., and by the Société Anonyme pour le Travail Electrique des Metaux in France. The chloride battery is suitable for private installations, central stations, and for traction work; in the latter case the cells are specially protected. All interested in these branches will find in the catalogue information which will be found of value.

Rating of Machinery.—At the forthcoming meeting of the Association of Chambers of Commerce, a resolution from Bradford will be moved on this subject. It is to the effect that having regard to the action of the Chorlton Union in assessing the whole of the machinery and tools of Sir Joseph Whitworth and Co., Limited, and seeing that there has hitherto been no generally recognised or uniform system pursued by the different rating authorities in the matter of rating of machinery, and that such absence of system has frequently caused injustice, and whereas the Rating of Machinery Bill introduced into the House of Commons proposes to establish a regular and uniform system of rating of machinery throughout England, it be resolved that her Majesty's Government be urged to afford facilities this session for the consideration and passing of the Rating of Machinery Bill, and that a copy of this resolution be forwarded to the President of the Local Government Board, and to the leader of the House of Commons.

Refuse Destructors.—A report of an interview with Mr. F. H. Medhurst, dealing with the employment of refuse destructors, was published in the *Pall Mall Gazette* on Saturday. Towards the close of the report Mr. Medhurst said: "It is probable that the next few years may bring improvements in incandescent lamps, but in respect of generating plant and the conductors for conveying the electricity we have reached something akin to finality. Let me, as my last word, make it clear that the idea of utilising this waste heat in this manner does not originate with me. Prof. George Forbes was the first engineer to seriously propose such a scheme, in reference to Edinburgh, but nothing practical was done. Mr. Manville, too, has worked hard in the same direction, and has prepared a refuse-destructor scheme in conjunction with an electric light installation on a large scale for Shoreditch Vestry; but I believe the further consideration of the question has been postponed for some months." The interviewer forgot to record the work accomplished by Mr. Jones at Ealing.

Lightning and Telegraph Posts.—A French contemporary chronicles some curious effects which lately occurred to a number of telegraph posts during a thunderstorm. They appear to have shared in a violent lightning discharge which split some of them from top to bottom, others had large splinters taken off, their tops knocked away, or bore the mark of a wavy discharge in spiral fashion round the stems. The conclusion arrived at is that just as prudence forbids one

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to shelter under a tree in a thunderstorm, so also the neighbourhood of telegraph posts is to be avoided. To our minds it seems curious that better provision was not made to carry away the discharge: it is usual to fix a lightning-conductor on every post, and this may have been done in this case, though apparently to small purpose. The erratic nature of lightning discharges is, however, well known, and since mechanical reasons forbid ensuring safety by giving the timber posts sufficient self-induction (!) to send the discharge always to earth down the wire, probably things must remain as they are.

The Pacific Cable Question.—A telegram from Ottawa on Tuesday states that the preliminary negotiations in connection with the proposed Pacific cable have made great progress during the past few weeks. The Canadian Government recently asked the views of the Australian Governments on the question of State ownership, and at the same time forwarded a revised offer on the part of the lowest tenderer to construct the line, comprising greater speed and a transmitting capacity of either 15 or 18 words a minute. With this change the cost was found to be much less than the estimate furnished at the Inter-Colonial Conference last year. No objection was raised by the tenderer to construct and maintain a cable *vid* Fanning Island. The Foreign Relations Committee of the Senate at Washington considered on the 24th ult. the resolution in favour of permitting the landing in Hawaii of the Pacific cable from Canada, and decided to present an adverse report. The committee recently appointed reported to the Senate, on Tuesday, an amendment upon the Consular Diplomatic Bill for the fiscal year appropriating a further sum of half a million dollars in order that a cable to Hawaii may be laid.

Science Schools.—The Science and Art Department of the Committee of Council on Education have issued a circular containing a scheme of rules for organised science schools. These rules will take the place of Sections 22 to 28, pp. 33 to 36, of the Science and Art Directory, and will come into force after the next examination in May. The most important feature of the scheme is the introduction of payment on inspection instead of payment on results for by far the larger part of the instruction given in organised science schools. This modification, which applies to 120 science schools in the United Kingdom, has become possible only since the appointment of a staff of science and art inspectors. Provision is also made for a certain amount of literary instruction being given whilst the student is pursuing his science curriculum. Greater freedom is given to the teacher as to the syllabus he is to teach in the first two years of a student's course. A choice of advanced courses is given; an alternative programme suitable for women is formulated, and instruction in subjects specially adapted to them is demanded; and practical instruction must be given in the subjects of science simultaneously with the theoretical instruction.

Another Explosion.—An explosion occurred last week in front of the Guildhall at Rochester, followed by the lifting up of some of the stones of the street pavement." On Wednesday Major Cardew, R.E, inspector to the Board of Trade, made an inspection of the scene of the explosion in High-street in the presence of Mr. Hurrell, electrical engineer and managing director of the Chatham and Rochester Electric Light Company. The statement of Mr. Hurrell is to the effect that the explosion occurred at the electric light company's No. 7 sub-station, and about 20 paving stones round and near the iron cover had been displaced. The explosion, it is said, had resulted from an accident which might not occur again in a thousand years. A spark had been found playing on a brick, which had fallen, owing to its being displaced by frost, on the high-tension terminal and on the iron tube of the low-tension main. Mr. Hurrell attributed the explosion to a faulty gas-main, and the gas coming in contact with the electric current had exploded in the ground near to the vault. Major Cardew intimated that he would submit a report to the Board of Trade, who would decide whether his visit should be followed by an official enquiry.

Electrical Communication with Lighthouses.—The scheme recommended by the Royal Commission having been sanctioned by the Treasury, telegraphic and telephonic communication in connection with the Liverpool lifeboat service have been established by the Post Office authorities. The new system provides telephonic intercommunication between the lifeboat station at Formby, the coastguard station at Blundell Sands, the Prince's landing-stage, the ferry-stage at New Brighton, and the Liverpool head post office, besides telegraphic communication between the latter office and the "look-out" stations at Voelnant (Point of Air), Hilbre, Hoylake, Bidston, and the Crosby lighthouse. On the Welsh coast the lighthouses on the Great Orme's Head and at Menai are now placed in communication with the lifeboat stations at Llandudno and Penmon respectively. The lighthouse on the South Stack, the signal station on the North Stack, and the lifeboat stations at Rhosneigir and Rhoscolyn are in direct telephonic communication with the coastguard station at Holyhead. The work of providing telephonic intercommunication between the coastguard station at Amlwch and Cemmaes, the signal station at Point Lynas, and the lifeboat stations at Bull Bay and Moelfra (the scene of the wreck of the "Royal Charter") will be perfected before the end of February, as also a telephonic extension to the lifeboat station at Llanddwynn, Carnarvon Bay.

Metropolitan Provisional Orders.—The Highways Committee reported to the London County Council on Tuesday that five applications have been made to the Board of Trade for electric lighting provisional orders this session. Three of these are made by the County of London and Brush Provincial Electric Lighting Company for powers in Battersea, Newington, and St. Olave's respectively, and the local authority in each case objects to the granting of the order; while the Charing Cross and Strand Electricity Supply Corporation seeks by the Strand order to include in its area of supply the Strand district, and the Notting Hill Electric Lighting Company by the Notting Hill order seeks to include in its area a part of Kensington, with respect to which the provisions of the House-to-House Company's order of 1889 were revoked on that company's application in 1893. As it was necessary that any observations upon the orders should be made to the Board of Trade as soon as possible, the Highways Committee have submitted on behalf of the Council, for the Board's consideration, certain amendments of the four first-mentioned orders to bring them into accord with the electric light legislation of 1892, and they have under consideration the question of suggesting to the Board the expediency of provisions being inserted limiting, if not prohibiting, the adoption under any one of the orders of a system of supply which would involve the construction of transformer-chambers of large size under the public streets. The committee do not consider that any action should be taken in regard to the Notting Hill order.

New Swindon Junior Engineering Society.—The members of this society assembled in good numbers last Saturday at the Mechanics' Institution to hear a paper on "The Distribution of Electrical Energy," by Mr. Douglas T. Heap, A.I.C.E., M.I.M.E. Mr. Heap received his mechanical training in the G.W.R. works at Swindon, and has for some

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years past held an important position under Messrs. Crompton and Co. He is an honorary member of the society, and travelled down from London to read his paper. The chairman, Mr. H. G. Cotsworth, pointed out that the only practical solution of the problem of the transmission of energy direct from the mouth of the coalpit to the manufacturing districts, there to be converted into mechanical work, was by the distribution of electrical energy, and suggested that the adoption of this system would play an important part in the abatement of the smoke nuisance. Mr. Heap opened his paper with an exhaustive analysis of the respective advantages, principles, and application of the two, three, and five wire systems of distribution. The great necessity of a simple yet efficient system of mains, and the conditions a good system should fulfil, were discussed at considerable length, and the Crompton, Kennedy, and Hopkinson bare-strip mains were described by means of diagrams. Most interesting information was imparted by a description of a piece, with joint, of the 10,000-volt Ferranti main as used between Deptford and London, kindly lent by the Institution of Electrical Engineers. As a sequel to the recent explosions of coal gas accumulated in culverts, the author thought that the next important step in electrical engineering should be the perfecting of the ventilation of main culverts. Cables, their requirements, and the relative advantages of pure rubber, jute, and paper as cable-insulating materials were considered; and in speaking of the insulation tests, Mr. Heap said it was imperative that the cable should be submerged in water at least 24 hours before testing. Porcelain insulators, he said, should be very closely grained (better obtained by deposition), and baked at 1,200deg. C. to give the best results. In conclusion, the author expressed his indebtedness to Messrs. Henley and the British Insulated Wire Company for samples of cables, and Messrs. Doulton and Co. for insulators and culverts. It was mentioned that Mr. J. W. D. Clinch will read a paper on "Hydraulic Cranes and Lifts" before the society on the 14th inst.

The "New Street Danger."—Under this title the *Lancet* makes some pertinent remarks bearing upon the subject discussed in this journal last and this week. Our contemporary says: "The 'new street danger' is losing its novelty. Owing to the alarm caused by the frequency and danger of such accidents, it is now proposed to present a petition to the Board of Trade that immediate steps be taken to prevent their recurrence. It is, however, difficult to believe that that Board, aware of the danger and fully informed of the facts, will delay effective action until urged forward under pressure of a public petition. It is not to be doubted—(1) that serious explosions may occur in connection with electrical leakage in underground mains both on the high-pressure and on the low-pressure systems; (2) that in consequence of leakage from high-pressure mains into the surrounding ground men have been injured and horses killed by electric shock; and (3) that such accidents are to be regarded as 'preventable.' The causes that lead to them are becoming fairly well known. It is recognised that among the measures to avert these occurrences are to be enumerated a due regard to the kind and construction of cables, care and foresight in the laying of mains, a proper 'earthing' of the outer conductor of concentric cables, efficient insulation, precautions to secure ventilation and drainage of culverts and junction-boxes, and an efficient inspection of the entire system. Such accidents are to be deplored, not only on account of danger to the public, but also in the interests of electric lighting. The electrical engineer is aware that long before he appeared on the scene with his cables and conduits and junction-boxes a notorious gas leakage had long held possession of the ground. It lies with him to meet the difficulty, and he will doubtless prove equal to the occasion. It has been suggested that some gas other than a mixture of coal gas and air—a gas 'distilled off the insulating substances' by the heated conductor—may at times be concerned in such explosions. This is possible, and in some cases perhaps probable. 'The man in the street,' however, is not seriously concerned to know the exact nature of the explosive gas, or the genesis of the spark or arc that ignites it, neither does he claim an opinion as to whether safety is to be found in gas-tight junction-boxes, or in a return to the old method of buried mains; but in self-defence he ventures to enquire whether new regulations are needed, whether existing ones are carried out, whether Rule 15, which provides that boxes shall be kept free from water and gas, be a reasonable one, and, if so, has it been duly enforced?"

The Government and Telephony.—A deputation from the Association of Municipal Corporations had an interview on Thursday of last week with Mr. Arnold Morley, with reference to the draft agreements entered into with the National Telephone Company and the New Telephone Company. The Postmaster General was accompanied by Mr. Spencer Walpole, Sir Robert Hunter, Mr. J. C. Lamb, Mr. Ogilvie, and Mr. Burrell. Sir Samuel Johnson, town clerk of Nottingham, introduced the deputation, who explained their objections to the agreement. The Postmaster-General, in reply, said the agreement was really one made by the late Government, the heads of agreement having been signed in July, 1892, by the then Postmaster-General, Sir James Fergusson; and all that he had done was to embody that arrangement into the formal legal document which was laid upon the table at the close of last session, and which would probably come up for discussion in the early part of the coming session. With the experience of the purchase of the telegraphs, the Government was not prepared to enter into the question of the compulsory purchase of the telephone system from the companies who had been created licensees of the Post Office. It must be remembered that they were not dealing with new licenses; the licenses were granted many years ago, and had still seventeen years to run, and it would be contrary to the public policy of this country to revoke those licenses until they expired by the effluxion of time. The Government, therefore, had no power to impose conditions on the National Telephone Company with regard to either maximum charges or equality of charge, without their full consent during the continuance of their license. The agreement would be of substantial advantage to the commerce of this country, because it would undoubtedly lead to a development of the trunk-wire system, and therefore to the granting of fresh facilities. He was surprised that the municipal corporations objected to their having the absolute power of settling the question according to their own needs; and if they reconsidered the question remembering that they had their formidable and powerful association at their back, he thought they would come to the conclusion that, after all, the decision which was arrived at in 1892 was a wise decision. Whether ultimately—and that he thought would at some time or other be the outcome—the State should take over the whole matter, in view of what took place in 1870 with the telegraphs, the Government were not prepared to consider the question of compulsory purchase; they had to make the best they could of the present position, and his belief was that when the agreement was put into operation it would prove to be a very considerable step in advance. He thought the municipal corporations would be acting unwisely if they were to give other than a friendly approval of proposals which had received the sanction of the House of Commons, both in the House itself and in committee.

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THE INSTITUTION OF JUNIOR ENGINEERS.

TENTH ANNIVERSARY JOLLIFICATION.

When my editor handed me the invitation card and suggested that I might like to attend the dinner I shrugged my shoulders and said, "What, Saturday night again?" "Yes," he replied; "why not? Is not Saturday as good as any other day?"

I thought it was better—for one reason at least, but not for dinners. Still, I tried to get out of it. "Look here, chief, the card reads 'morning dress.' I can't go in morning dress; it's not proper." "Now, none of your hocus-pocus," he exclaimed, angrily; "just you get and go as you are, or rather—looking at my appearance at the time—as you were this morning."

I had to go. So I went as my chief directed. I knew it would be so. Half of the fellows were dressed, and the remainder were—in morning attire. This was rather vexatious, especially at the Westminster Palace Hotel.

Mr. Alexander Siemens, the president of the society, gave one and all a hearty welcome, reminding me of his gracious reception at the recent dinner of the Institution of Electrical Engineers.

I caught my eye on many familiar faces, one being that of the representative of my yellow-coated contemporary. I and he got chatting, and, as luck would have it, found that we were neighbours at the same table. The gentlemen present were:

LIST OF GUESTS.

Mr. Siemens (president).
Mr. Young (chairman).
Mr. Newman (vice-chairman).
Major-General Webber, C.B.
Prof. Ewing, F.R.S.
Mr. S. H. Wells.
Prof. Forbes, F.R.S.
Prof. Ayrton, F.R.S.
Prof. Hughes, F.R.S.
Mr. W. W. Beaumont.
Mr. Waldrom.
Mr. Vorley.
Mr. T. E. Gatehouse.
Mr. Spooner.
Mr. W. Powrie.
Mr. Boulding.
Mr. Tennant.
Mr. Fraser.
Mr. S. Cutler.
Mr. Dykes.
Mr. De Ritter.
Mr. W. Clarke.
Mr. Christ.
Mr. Le Tall.
Mr. Burtt.
Mr. Blakeney.
Mr. Fry.
Mr. Parker.
Mr. Walker.
Mr. Brown.
Mr. Winnoll.
Mr. Fuller.
Mr. Hosegood.
Mr. Fisher.
Mr. Arding.
Mr. L. Clarke.
Dr. Goldie.
Mr. Hunter.
Mr. Rea.
Mr. W. L. Powrie.
Mr. Youngman.
Mr. Woodhouse.
Mr. Beckton.
Mr. E. Cutler.
Mr. Sheppard.
Mr. Rowland.
Mr. Rugg.
Mr. MacAlister.
Mr. Morewood.
Mr. Pearson.
Mr. Crawter.
Mr. Narraway.
Mr. Cooke.
Mr. Wait.
Mr. Madden.
Mr. A. Willbond.
Mr. Wolff.
Mr. Rennie.
Mr. Taylor.
Mr. Kennett.
Mr. Morrison.
Mr. L. Gates.
Mr. E. Gates.
Mr. Roberts.
Mr. A. Marshall.
Mr. R. Marshall.
Mr. Jones.
Mr. P. Wells.
Mr. J. G. Sneath.
Mr. H. Johnson.
Mr. Leonardt.
Mr. J. N. Boot.
Mr. Gill.
Mr. Boot.
Mr. Marriott.
Mr. Newson.
Mr. Sneath.
Mr. Bignall.
Mr. Gatehouse.
Mr. Dunn (secretary).
Mr. Dickson.
Mr. Stanley.
Mr. King.
Mr. Lane.
Mr. Stuart.
Mr. Johnson.

If you want to enjoy yourself a year hence, I would advise you to go to the next dinner of the Institution of Junior Engineers. I don't want to tell any secrets, but I cannot refrain from saying something of the proceedings on the present occasion. It was essentially a jollification. Wit and satire abounded, and it only required the presence of Mr. R. E. Crompton, who I am sorry to say was absent, to complete this interesting gathering.

TRICKS OF THE STAGE.

I do not know whether it was part of the programme, but after asking the gentlemen on the right and then those on his left to drink with him, Mr. Siemens forgot the gentlemen in the centre. So we in the centre rose in a body and—sat down again.

The president, who mentioned the absence of Prof. Perry through illness in his family, and of Sir Arthur Rollit, M.P., caused some amusement by, in the same breath, saying, "Gentlemen, please charge your glasses."

The toast of "The Queen" was honoured, and the National Anthem sung. It is rather mysterious that the presence of electricians at functions of this kind should cause a displacement of property. I do not mean a disappearance thereof. At Tunbridge Wells, for instance, on the occasion of Sir David Salomons's banquet three weeks ago, the discordant blasts of two trumpeters caused a pile of plates to smash. At least, so the *Electrical Review* stated. My own impression, however, was that a highly-charged body close to the plates did the mischief.

Now, at the Westminster Palace Hotel on Saturday, when the electricians joined in the singing of the National Anthem, a table bell was seen to suddenly *walk* towards the edge of one of the tables and fall with a bang on the floor. I hope Maskelyne and Cooke's tricks are not going to form part of the proceedings on future occasions. If so, I shall ask my chief to send the "Human Magnet" to represent him, for I declare emphatically that I will not go; and when I say I won't—why the "Human Magnet" draws me.

The toast of the "Royal Family" having being duly honoured,

The president gave some useful advice. I wish I had met him years ago, because that counsel would have served me in good stead—at least it might. At all events, it had no effect upon the members of the Junior Engineering Society. What do you think Mr. Siemens said? "Gentlemen, I have a communication to make to you. Those who are accustomed to smoke—smoke; those who are not, don't try." Of course the result was the reverse of what the president had anticipated. Everybody *did* smoke, and in half an hour there was not a dry eye in the room. I wonder how those who then smoked for the first time felt after the dinner?

THE LION AND THE LAMB.

Mr. SIEMENS, in proposing "Her Majesty's Sea and Land Forces," paid a tribute to these two branches, and referred to the time so often spoken of when the lion "would lie down with the lamb—*outside each other.*" If they wished for peace, let them be prepared for war. As an instance of German military life, he amused those present by stating that many persons entering the service were ignorant, but that they thereby learned how to read and write—and to wash themselves. When once asked whether he thought it was a good thing for a young man to be taken from his friends for military service, he replied, one might say with Scotch caution, that "it depends upon the family." Another little story was that of a major who, in the Franco-German War, when the French were peppering the Germans from the opposite bank of the river, was so absorbed with a momentous question about the river that when plied with questions he remarked, "I think there are trout in it."

Major-General WEBBER, with whose name the toast was coupled, responded by referring to the connection between art and science and engineering. As if he had been somewhat ruffled by "Simple Susan," he stated that the admiral of the present day was not the frantic old rascal now being represented in "Rebellious Susan." He impressed upon them the fact that many in the army were engineers; that mighty generals in the past had been engineers; and that if it were not for their engineering knowledge, the army would not be half so efficient as it is.

Mr. WM. POWRIE proposed "British Commerce," which was responded to by Mr. SPOONER.

The president, in calling upon Mr. R. W. Newman (vice chairman) to give the toast of "The Engineering Professors," asked the latter not to be too hard upon the professor, who not long ago had had Mr. Newman under his thumb. Instinctively I knew something was about to happen, and I have not yet settled in my own mind whether the whole thing had not been pre-arranged.

Mr. Newman rose with a merry twinkle in his eyes. I have seen that sign before, and know what it means. It is an indication that a crossing of swords is about to take place. It did. But before he commenced I hastily picked

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up the menu, or, as Mr. Siemens would put it, the *speisekarte*. There I saw at the top illustrations of a lobster and a crab engaged in mortal combat with swords. It was something like this:

LOBSTER—CRAB. THE INSTITUTION OF JUNIOR ENGINEERS.

I wonder what this means. Surely it is not a new definition of Ohm's law.

ENGINEERS' VIEWS OF PROFESSORS.

Mr. NEWMAN, in giving the toast, said that as junior engineers they had a kind of impression that the engineering professors were a kind of superfluity. (What! who was it cried out "Oh"?) They seemed to think that the only road to success was practical training. But those who knew the abuse of putting a young lad direct from school into a shop, were aware that it was a wrong step to take. It seemed to him that the future engineer should be placed, say, for two years under one of those gentlemen, the professors. (I made no mistake this time, for I distinctly heard "hear, hear.") The speaker regretted that he had not remained longer with Prof. Reynolds, of Manchester. When he complained to that gentleman that he would prefer the practical side of life, the professor replied, "I hope you will get it." He had always remembered those words. Now, however, he would like some of the practical diluted with a little of the theory. Twenty years ago—and everybody laughed at this sally—the professor was in his infancy; he was like a baby, and as he was getting older he was getting kicked about from pillar to post. As, however, years passed by, they would more and more feel that their future training should be laid on a scientific basis, and not upon the elementary education which they received at schools. (No, not Board schools, gentlemen of the daily Press, and a little less ——phemy please.) As an institution they had much to thank the professors for what they had done for them.

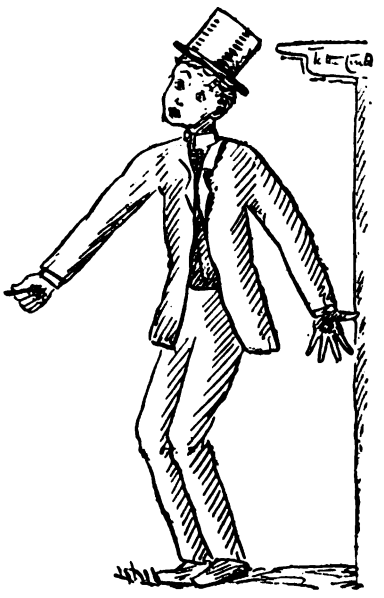
Prof. W. E. Ayrton acknowledged the toast. It did not require a glance at the toast list to inform me that he would do so. His diligent attention to the remarks made by Mr. Newman afforded sufficient proof, and when he rose I knew that he had a card up his sleeve. It was the trump card, and it won. It was well played, and no one could have played it better. When he got up from his seat, with his eyelids cast down and his hands upon his hips, he got the desired effect. A storm of applause burst through the room, and the professor, bowing his head like a weeping willow, knew that his hour of triumph had arrived.

THE TRUMP CARD WINS.

Prof. AYRTON, with the twinkle of mischief in his eyes, said that, of course, fun had been poked at professors. It was always so, and he supposed it was because there was a popular impression that teaching was the refuge of the destitute, so that when a man had convinced himself that he had no knowledge he straightway became a professor. A professor imparted his ignorance to his pupils. The subdivision of labour had, however, rendered it impossible for the master of the works to give to every individual apprentice that sort of paternal instruction which he formerly did, so it had been given to the technical teacher to help the master of the works. It was therefore not to be wondered at that the methods employed by the technical teacher were quite different from those adopted by the schoolmaster. There were three periods in the life of a man. They were (1) from birth to seven years, (2) from seven years to 17, and (3) from 17—until he died. During the first seven years the infant was guided by his own experience; during the period of 10 years he was guided by what his grandfather had done, and that was wrong; and during the latter portion of his life—well—— The professor then went on to say that since he had been in the room he had received a communication from a young girl (I fail to understand why there were so many "Oh's!" and laughs at this remark. Certainly it is in order for a professor to receive such a note. I am sure I should not have objected). Well, if a young girl was not satisfactory, he would say a young lady. He was her guardian. It was a letter with illustrations—a remarkable letter. Then the professor held up the letter, which he read, and showed the illustrations. I give below the lines, together with the pen-and-ink sketches. As a result, I am determined to become a professor at once.

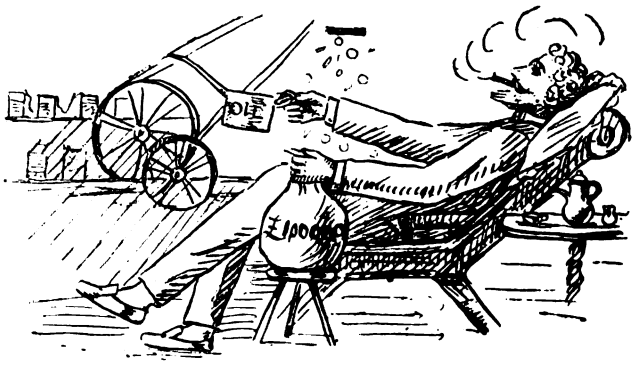
MISS M——'S VERSION OF "PUT A PENNY IN THE SLOT."

It is rumoured that Ayrton and Perry
A wonderful system have got
For the teaching of practical science
By putting a coin in the slot.



A student arrives at the Central,
His mind an absolute blank,
Yet he leaves simply teeming with knowledge
Imparted by turning a crank.

While as for my eminent guardian,
I suppose all his labour has been



To pick up the showers of money
And pensively oil the machine.

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Then bring us the laurel and myrtle,
And bring us the garlands of bay,
Let us crown the brave Ayrton and Perry
For showing so royal a way.

Let everyone go to that college,
Let us all drop our coins in and see,
If her guardian would but turn the handle,
How wise even Tina might be.

A FIRST PROPOSAL.

In the one case you will see the perfect idiot going to the Central; in another he comes out with a diploma after one day's course; in the third the professor is depicted lying on a sofa, picking up money and oiling the machine; and in the fourth the professors are making merry over their success. I am perfectly certain that had I libelled the professors in the same manner as Miss M—— has done, I should get six months—holiday.

At any rate, my chief is so pleased with the artistic talent indicated by the sketches, that he is prepared to enter into an arrangement with Miss M—— to regularly contribute to this journal. Consequently, if Miss M—— will call at this office, I shall be happy to make arrangements, on behalf of my chief, for Miss M—— to make sketches whilst I scribble, as in the case of the *Daily Graphic*. I wish it to be distinctly understood that no other application will be entertained.

Prof. EWING, who also acknowledged the toast, referred to the term "hysteresis" proposed by him years ago. At the time the investigations into the magnetisation of iron were made, no one had any idea that it would have such an important effect upon the industry. Even if the professor worked on the penny-in-the-slot system, he did not get his penny if he did not work the machine properly.

ORANGE V. BLUE.

Prof. GEORGE FORBES, who rose to propose what the president called the toast of the evening, "The Institution of Junior Engineers," has evidently been reading no electrical journal other than the *Electrical Engineer*. He mistook some uncomplimentary remarks published recently in my orange-covered contemporary anent professors as having emanated from my esteemed friend the *Electrical Review*. When he looked at Mr. Alabaster the professor said that he was convinced that it was not he, but Mr. Gatehouse, who was responsible for the statements referred to. When, however, he glanced at Mr. Gatehouse, he was quite sure that the latter was free from blame, and that it was due to Mr. Alabaster. But the professor here discovered that he was on the wrong track, admitted it, and blue won again.

I do not like No. 13. Neither does Prof. Forbes. He said that when he came into the room and found No. 13 was the number of his seat, something was going to happen. It did, and resulted, as shown, in the professor confounding orange colour with blue. The speaker then eulogised the importance of the institution, and, in praising their policy of visiting different works and thereby gaining an insight into various branches of engineering, referred to the projected excursion of the institution this year to Belgium.

Mr. H. Y. YOUNG (chairman of the institution) suitably responded.

Other toasts included "Absent Members," proposed by Mr. A. H. DYKES and acknowledged by Mr. H. S. WELLS; "The President," by Mr. W. W. BEAUMONT and responded to by Mr. SIEMENS; and "Mr. J. W. Dunn," the secretary, put by Prof. AYRTON, and suitably acknowledged by the SECRETARY.

MUSICAL HONOURS.

During the evening pianoforte solos were rendered by Mr. A. H. Stanley and violin solos by Mr. T. E. Gatehouse, whilst recitations were given by Messrs. A. W. Marshall and W. T. Dunn.

At 11.25 I hastened away to catch my train, whilst those remaining stood up to warble "Auld Lang Syne." Ever since then the penny-in-the-slot machine has been running through my mind, and if I can only manage to remain awake for two nights longer I believe I shall have solved the mystery of, if not perpetual motion or the hansom cab, certainly that of making money by becoming a professor. At all events, I can already see engraved on my door plate the words PROF. PRIVATDOCENT.

THE PREVENTION OF EXPLOSIONS IN CONNECTION WITH UNDERGROUND MAINS.

In our last issue we printed the opinions of some central-station engineers on this important subject, and we now give a further instalment.

Aberdare.

Messrs. GEO. WILSON AND CO. write that as their installation is an overhead one, they have no replies to give.

Brighton.

Mr. ARTHUR WRIGHT, the Corporation electrical engineer, reports that no culverts or conduits are used.

Chelsea.

Mr. PERCY STILL, the engineer to the Chelsea Electricity Supply Company, replies to the questions in the negative.

Dublin.

Mr. MARK RUDDLE, the superintending engineer, observes that he has experienced no trouble through accumulations of gas. Respecting ventilation, he states that ventilation through the joints of the street-box covers, assisted by the connections to arc lamp-posts, seems to be sufficient. In high-pressure systems there is less need of ventilation if there are no exposed connections. Still, conduits should be kept free from chance of gas accumulating. In low-pressure work, ventilation assisted by a current of dry air from a fan is most essential for many reasons. Where required, the culverts are trapped into the sewers. There has been no trouble on the point of electrolysis.

Dundee.

Mr. W. H. BROWNLEE, the engineer to the Dundee station, has not found any difficulty in regard to gas. The culvert is ventilated into the station chimney stack, and this method has proved successful. Mr. Brownlee regards as the most practical method of preventing explosions the provision of plenty of inlets for air, with a fan exhausting at the end of the culvert. The culverts are drained into the sewers at the lowest points through Buchan traps. There has been no trouble through electrolysis.

Exeter.

Mr. H. D. MUNRO, engineer-in-charge of the Exeter Electric Light Company, informs us that the company have had no trouble on the score of explosions. They have no conduits or pipes, the whole of mains, high and low pressure, being concentric lead covered and armoured, and there is a continuous metallic sheathing connected to earth over the whole system, including joint-boxes, switch-boxes, etc. This system, he states, should secure them from any risk of explosions. Mr. Munro considers that some system of forced draught would be the most practical method of preventing explosions in conduit systems. Sealed pipes and

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ventilating shafts for boxes and chambers should be used in the case of pipe systems. In regard to drainage, the street boxes are drained to the sewers. Electrolysis has not caused any trouble.

Kelvinside.

Mr. W. ELSDON-DEW, resident engineer of the Kelvinside Electricity Company, states that no difficulty has arisen from accumulations of gas. The system adopted by the company is steel-armoured and lead-covered cable laid direct in the ground. He considers that this method will be used much more universally when its many advantages are recognised and the means of manufacture improved. Concerning drainage, the writer says that all the joint-box chambers are drained by means of a trapped drain connected to the main sewers.

Keswick.

Mr. JOHN SHIPP, the manager of the Keswick Company, states that in the past they have had considerable trouble through explosions of gas in conduits and pipes. Where the lines of cables run parallel or near to gas-pipes, the conduits and pipes are freed from gas by means of 1⅛in. iron pipes connected either to the manholes or to the culverts containing the cables, and fixed to the nearest building. This method has proved effective. No system of ventilation other than that mentioned has been tried. Mr. Shipp considers the most practical method of preventing explosions in conduits is by arranging for the escape of gas by means of pipes similar to those referred to. In pipe systems he would connect an outlet pipe to all manholes. Wherever practicable, all culverts have been connected to the main drain or sewer. No trouble has arisen through electrolysis.

Morecambe.

Mr. J. JOWETT, the secretary of the Morecambe Electric Light and Power Company, replies in the negative to all our questions.

Newcastle.

Mr. W. SHORT, the secretary of the Newcastle-upon-Tyne Electric Supply Company, writes that the company have received our letter of queries regarding gas explosions, but that they are unable to give us the desired information.

Northampton.

Mr. W. E. HEENAN, the engineer to the Northampton Company, has not experienced any difficulty in regard to accumulations of gas. The company have not adopted any method of ventilation. Dealing with the question of drainage, Mr. Heenan remarks that they have placed at the bottom of most inclines a drain with a syphon before entering the main drain. No trouble has been caused by electrolysis.

Weybridge.

Mr. H. C. BUCHANAN, the secretary of the Weybridge Electric Supply Company, writes that as all their mains are overhead he cannot give us any information on the subject.

We give below the opinions of other engineers:

Mr. E. Manville

has experienced trouble through coal gas on one occasion. It was due to gas accumulating in an arc lamp service pipe, and being fired by a faulty arcing switch. The difficulty has been overcome by plugging the entrances to the service pipes. Mr. Manville does not consider that ventilation is required, the conductors in all cases being insulated, and so not able to spark, and in contact with metal pipes the system concentric with the "outer" earthed. The most practical method of preventing explosions is to use concentric systems with the outer earthed. With regard to drainage, the pipes drain into drawing-in boxes with open bottoms. No difficulty has been experienced through electrolysis.

Mr. Francis H. Medhurst

has not experienced any trouble through the collection of gas in underground systems. Discussing the question of ventilation, he observes that he has employed a blower to force *dry* air through the whole system of pipes. This not only keeps insulation dry and good, but also forces out gas should any find its way into the pipes. The most practical method of preventing explosions in conduit systems is to adopt ventilation and frequent inspection, although he strongly disapproves of conduit systems. Concerning drainage, Mr. Medhurst states that he employs a drain in connection with the main sewer at the sub-station. In practice, no draining is necessary if pipes be all well jointed with yarn and lead and rubber washers used for junction-box covers and for bolting pipes to junction-boxes. He has not found any difficulty in regard to electrolysis.

Sir David Salomons.

In reply to our questions, Sir David Salomons cites the case of the City of London Company. The system used by the company comprises mains drawn into Callender-Webber casings for a small portion, but for the greater area of the city they are drawn into wrought-iron screwed tubes. Some cables are single, some concentric, some triple concentric—all kinds of makes. So far as regards risk of explosion in the tubes themselves, Sir David is confident that no danger whatever can arise in this portion of the system. Some years ago he experimented with iron tubing similar in character to that which is used in the City, and he was unable to burst the pipes by using coal gas and air in the most favourable proportions for producing an explosion—*i.e.*, about one part gas to seven parts air. In the case of the tubes in the City, the space being so largely occupied by the cable, the risk of the pipes bursting is practically nil. The Callender-Webber casing, he states, is perhaps not so favourable in this respect, although he does not think that any explosion of gas in these conduits would move the ground above. The service-boxes are small, and almost completely occupied with material, so that the risk of damage by explosion at these points is also exceedingly small. The really dangerous part of the system is the draw-boxes, which are very large spaces. The company have already had a few accidents at these points, the most recent one being that in Cannon-street. It was shown in this case that the danger of ignited gas and air in the tubes is nil. The gas was fired along the tube with no ill effects until it reached the draw-box. Sir David Salomons has always held that it is practically impossible to keep the gas out of the electric lighting system when laid in conduits, which must necessarily entail draw-boxes. He considers that ventilation will make matters worse, since it will tend to draw the gas from any leaky point in the gas-mains into the system more freely. Compressed air would undoubtedly cure the evil, but this is quite impracticable in a large network. There is only one way, to his mind, by which the evil can be remedied, and that is by leaving no space for the gas to occupy, or a space so small that if an explosion did occur no damage would result. Sir David long ago proposed filling all the large spaces, such as the draw-boxes, with sand or slag-wool. In both cases there are certain disadvantages attaching to this course. He has now hit on a plan which will remove the disadvantages, and it is going to be adopted as an experiment on parts of the City Company's system. It is that of putting the sand into sacks to occupy the larger space at the bottom of these draw-boxes, and to fill up the remainder of the space with smaller bags containing the same material. It will then, of course, be easy at any time under this arrangement to remove the sand if it becomes necessary to enter the box for any purpose.

Mr. James N. Shoolbred

has never had (nor heard of) any trouble at any of the town supply installations which he has laid down, such as Bradford and Brighton, arising from accumulations of gas or water, for the simple reason that he never makes use of conduits or pipes if they can be avoided. The cables are invariably of the underground "armoured" class, laid direct in a trench in the ground, which is filled in again. The interior of the cast-iron street boxes and other connections are filled up solid, and so kept air and water tight. The filling can readily be removed should the electric connections be required to be exposed for testing or other purposes. The brick pits in which street boxes are placed (if required to be readily accessible), as well as the protecting brick conduits (at road crossings, etc.) and the iron protecting pipes, are allowed facilities for drainage into the adjoining soil, etc. Furthermore, interruptions in the

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electrical supply and extinctions in the lighting have been prevented (at the above towns) by a suitable reserve of electrical storage; whilst electric shocks fatal to life have also been avoided by adhering to low pressure in the mains as defined by the Board of Trade regulations. Mr. Shoolbred states that the numerous accidents set down to electricity which have occurred of late, have disclosed in the several enquiries which have followed them a large amount of carelessness, and of disregard for the proper safety of the public, both in the design and in the working of the respective electric installations. He hopes, therefore, that a careful consideration of the above-stated precautions may not be thought ill-timed or out of place at present, when so many new electric installations are being laid down, the more especially, since the above two electricity supplies, as well as others, both in the Metropolis and in the provinces (and where similar precautions are in use), have been preserved entirely during the past few years from any of the so-called accidents due to electricity.

ELECTRIC DISCHARGE THROUGH GASES.*

BY PROF. J. J. THOMSON, M.A., SC.D., F.R.S.

One of the most important and interesting branches of physical science is that which deals with the connection between electrical and chemical effects. The investigations on electrolysis made within these walls by Davy and Faraday proved that the important class of electrical phenomena associated with the passage of electricity through liquids, are connected in the closest way with chemical action. They proved that no electricity will pass through most liquids unless chemical action occurs, and that for each unit of electricity which passes through the liquid there is a definite amount of chemical decomposition. This case, though it is one where the laws are most accurately known, is but one among many electrical phenomena which are inseparable from chemical action. So many instances of this kind have been discovered that we may perhaps venture to hope that we are not far from the time when it will be universally recognised that many of the most fundamental questions in chemistry and electricity are but different aspects of one and the same phenomenon. Anything which throws light on the connection between electricity and matter, interesting as it is on its own account, acquires additional interest when regarded as elucidating the connection between chemical and electrical effects, and no phenomena seem more suitable for this purpose than those which are the subject of the discourse this evening—the discharge of electricity through gases. For in gases we have matter in the state in which its properties have been most carefully studied, while the investigation of the electrical effects is facilitated by the visibility of the discharge, affording us ocular, and not merely circumstantial, evidence of what is taking place.

The points to which I wish to refer particularly this evening are—firstly, some phenomena connected with the passage of electricity from the gas to the electrode, or from the electrode to the gas; and secondly, some of the properties of the discharge when its course lies entirely in the gas. By taking a long discharge tube, say, one 50ft. long, and observing the luminous discharge through a rotating mirror, we can trace the course of the luminosity due to a single discharge, say, one due to once breaking the primary circuit of an induction coil; if we do so we find that the luminosity follows the direction of the positive current through the tube. That is, the luminosity begins at the positive electrode, it then rushes down the tube with enormous velocity, but when it gets to the negative electrode it receives a check; it does not disappear at once in that electrode like a rabbit going down a hole, but lingers around the electrode some time before entering it. In consequence of this delay in the positive discharge in getting out of the gas, there is an accumulation of positive electricity in the neighbourhood of the negative electrode until the potential fall at this electrode increases to about 200 or 300 volts. The positive electricity which accompanies the discharge thus finds considerable difficulty in getting from the gas to the metal, though, as I hope to show you later on, as long as it keeps in the gas it meets with what we may, in consideration of the views sometimes enunciated on this subject, call a ridiculously small amount of resistance; its real difficulty is to get out of the gas. Though this effect has long been known, it is so important that I will venture to show one or two experiments which illustrate it. The arrangement of the first experiment is shown on the screen. The apparatus consists of a main discharge tube, across which is fastened a diaphragm made of excessively thin platinum leaf. There is a side passage from the tube, leading from one side of the diaphragm to the other; this is connected to a barometer tube, and by raising the cistern containing the mercury I can stop up the passage by a pellet of mercury. We will first observe the discharge when the side passage is open.

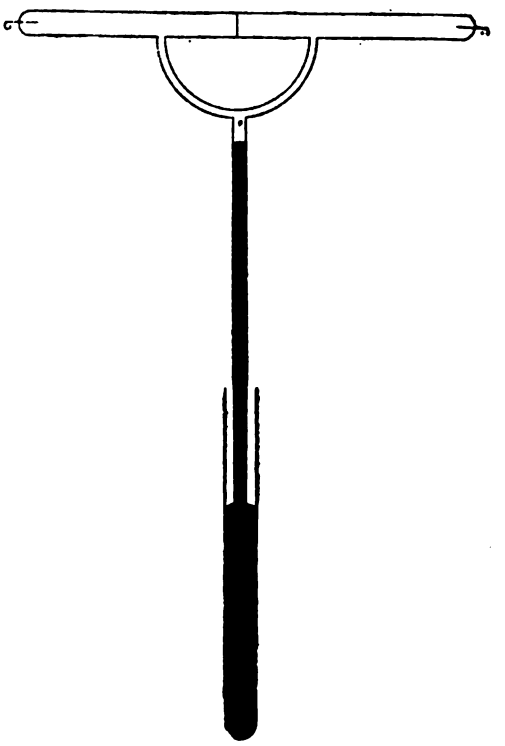

FIG. 1.

You see that the discharge, instead of passing across the thin piece of platinum leaf, takes the very much longer route round the side tube, so as to avoid crossing the metal. We will now raise the mercury-cistern and close the side tube by a pellet of mercury; the discharge now has no alternative but to cross the metal at some part of its course, and you see that the main portion of the discharge goes back into the main tube.

In the second experiment the metal diaphragm is replaced by a very thin plate of mica; when the side passage is opened the discharge goes round, but when this is closed by a pellet of mercury the discharge prefers to go across the mica than through the mercury. A second experiment which shows the same thing is the following:

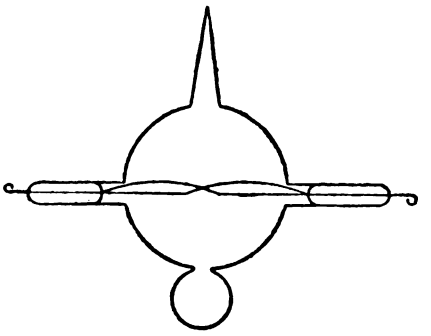

FIG. 2.

Two long electrodes are fused into a bulb, so that the tip of an electrode is a considerable distance from the place where it passes through the glass. We will now send an

* Paper read before the Royal Institution of Great Britain.

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alternating discharge through the tube, and you will see, I think, that the discharge, instead of going straight across the short distance between the ends of the electrodes, goes from the tip of one electrode to the place where the other passes through the glass, thus staying as long as possible in the gas before passing into the metal. The appearance of the discharge shows that the positive electrode is at the end of the wire, the negative at the junction of the wire with the glass. Another interesting example of the difficulty the discharge experiences in passing from gas to metal is the discovery made by Profs. Liveing and Dewar, that when the discharge passes through a gas containing a large quantity of metallic dust, the light from the discharge, when examined in the spectroscope, does not show any of the lines of the metal.

The difficulty which the positive electricity finds in passing from the gas to the electrode depends a great deal upon the nature of the gas as well as upon that of the electrode; it is influenced by the position of the gas and the electrode relatively to one another in the electro-chemical series. I have lately made a series of experiments on this point in the following way: An alternating discharge from a high-tension transformer was made to pass between two electrodes fused into a bulb, which could be filled with the gases under examination. Another electrode connected to an electrometer passed into the bulb, and was arranged so that it could be moved about from one part of it to the other. When the electrodes were metal and the bulb was filled with the electro-negative gas oxygen, the electrode received a positive charge in whatever part of the bulb it was situated; if now the bulb was filled with hydrogen at atmospheric pressure, then in the regions remote from the arc the electrode received a positive charge, but in the immediate neighbourhood of the arc itself it received a negative charge. When the pressure was reduced the region in which the charge was negative contracted, and, finally, at pressures about one-third of an atmosphere seemed to disappear, and the electrode got a slight positive charge in whatever position it was placed. If now, instead of using metallic electrodes, we use well oxidised copper ones, and repeat the experiment in hydrogen, working at a pressure when there was only positive electricity when the electrodes were bright and polished, we find that with the oxidised electrodes every particle of positive electricity is taken out of the tube, and a negative charge is left. This negative charge remains until the copper oxide is completely reduced; when this occurs the negative charge disappears, and is replaced by positive. Thus, under the same conditions as to the nature of the gas and the pressure, the bright copper electrodes leave a positive charge in the gas, while the oxidised ones leave a negative charge.

The most probable explanation of these results seems to me to be the view that the communication of electricity from gas to the electrode, or from the electrode to gas, is facilitated by the temporary formation of something of the nature of a chemical compound between the gas and the metal. In all such compounds the metal is the electro-positive element, and has the positive charge, the gas being the electro-negative and carrying the negative charge. Now, consider the case when the negative charge is on the gas and the positive charge on the metal; then the gas and metal have got the charges proper to them in any compound they may form, and are thus in a fit state to combine, or, according to this view, allow the negative electricity to pass from the gas to the copper. But, now, suppose the gas was positively electrified, the gas and the metal have now opposite charges to those proper to them in a compound, and before the union of gas and metal in this state could result in anything but a most unstable compound, an additional process must be gone through—*i.e.*, the charges on the gas and metal must be interchanged. Thus the conditions for the combination of the gas and metal are more complex when the gas is positively electrified than when it is negatively electrified, and thus, on the view that the communication of electricity between the gas and the metal involves a sort of chemical combination, we see that the negative electricity will escape more easily from the gas to the metal than the positive. Now consider the case when the gas was hydrogen, the electrodes oxidised copper; the hydrogen combines now, not with the metal, but with the oxygen, forming water, in which hydrogen is the electro-positive element; thus, in this case, it is the positively-charged hydrogen which is in the state best fitted for pairing. The consequence is the positive charge would be most readily removed from the gas and the negative left, exactly the opposite to that which occurred when the electrodes were bright. This reversal, as I stated before, is verified by experiment.

I have hitherto only spoken of the phenomena which accompany the passage of electricity from the electrode to the gas, or from the gas to the electrode. I shall now pass on to consider the properties of the discharge when it is entirely confined to the gas. We may produce a discharge which, during the whole of its course, shall be confined to the gas in the way represented in the diagram. The two poles of a Wimshurst machine are connected to the insides of two jars, A and B, while the outsides of these jars are connected together by a metal wire wound so as to form a coil. The electricity from the Wimshurst machine charges up the jars, the difference of potential between the poles increases until a spark passes. The passage of the spark puts the insides of the two jars in connection, and the jars are discharged. The discharge of the jar, as was proved from the theory of electromagnet action by Lord Kelvin more than 40 years ago, and shortly afterwards confirmed by the experiments of Feddersen, is an oscillatory one, producing currents surging backwards and forwards through the wires with extraordinary rapidity.

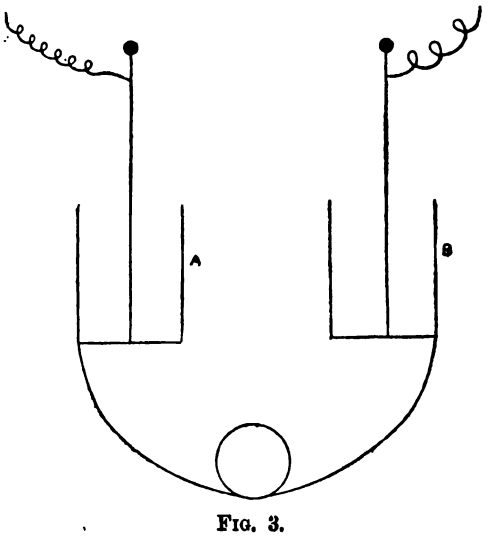

FIG. 3.

The subject of these oscillatory currents is one which in this year is tinged with melancholy. The year had hardly commenced when we lost Hertz, whose splendid work on these electrical oscillations is known to you all. The managers of this institution have marked their sense of the importance of this work by devoting a special lecture this session to this work alone, and they have entrusted that lecture to a most distinguished worker in the same field as Hertz. It would therefore be presumptuous on my part to refer in any detail to Hertz's work, but no physicist, and least of all one who is a member of Maxwell's university, could pass over in silence the death of Hertz. When Hertz began his magnificent experiments on electric oscillations, there were many theories of electrical action. When he had finished them there was only one—Clerk Maxwell's. Hertz's work was done with very much quicker vibrations than those produced by the apparatus now on the screen; this, however, gives rise to currents through the coil changing their direction some million times a second. If we place in the coil an exhausted bulb, the bulb in reality will be the secondary of an induction coil, and will be exposed to E.M.F.'s tending to produce circular currents parallel to the plane of the coil. I will now place a bulb inside this coil, and you see that a circular ring discharge passes through it, and this discharge passes entirely in the gas. The gas in the bulb now in the coil is the vapour of silicon tetrachloride; it happens to be the bulb which gives a brighter ring than

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any others I possess. If this ring discharge passes through air at different pressures, the colour of the discharge changes very considerably. The first bulb I put in was at fairly high pressure, about one-tenth of a millimetre or so. I will now put in another at a lower pressure, and then one at a still lower pressure. Mr. Newall, who has been working at the spectra of these discharges, finds that at the pressure in the first bulb the spectrum is due to nitrogen; at the second stage it is due to mercury vapour; the bulb was pumped by a mercury-pump, so that there is in the bulb a certain quantity of mercury vapour. The apple-green colour in the more highly-exhausted bulb is due to some compound of sulphur, which has got into the bulb from the sulphuric acid used to dry the gas. Mr. Newall finds that if the ordinary discharge from a coil between electrodes is taken in such a bulb, there is no trace of this sulphur spectrum. He has also found that when the bulb is at a pressure intermediate between what I may call the mercury and the sulphur stage, when the mercury and sulphur lines are both visible, these sets of lines come from different layers, the sulphur lines coming from a layer nearer the surface than the other. If we take the discharge through a bulb containing oxygen, you see that the ring discharge is succeeded by a bright glow; at first the colour is somewhat opaque, but gradually sets more transparent and changes colour. This gives a continuous spectrum crossed by a few bright lines. If we take the discharge through cyanogen you see that the glow is even more persistent than the oxygen, though it is not so bright; all the gases which show this glow belong to the class of substances which polymerise—that is, whose molecules can combine with each other. I imagine that what takes place in bulbs filled with these substances is that the discharge produces a polymeric modification, and that this gradually returns to its original state, and while doing so gives out a phosphorescent light. It is in accordance with this that at a high temperature where ozone cannot exist a discharge through an oxygen bulb does not show any glow.

I said at the beginning of this discourse that gases were exceedingly good conductors of electricity. I will now endeavour to show an experiment which proves that statement. The apparatus which I shall use for this purpose is a slight modification of the one I have used

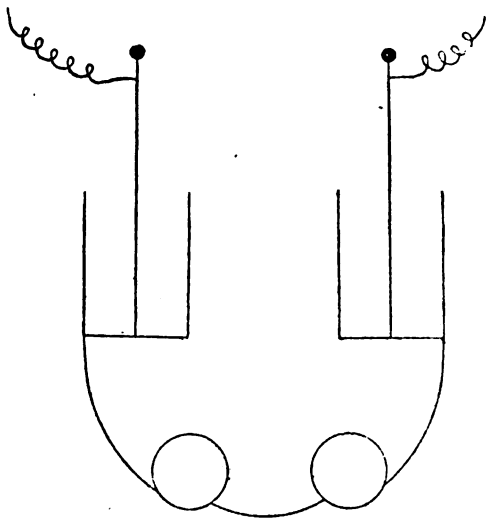

Fig. 4.

for producing the ring discharge—the only difference is that in the wire connecting the two coatings of the jars there are two loops instead of one. In one of these loops an exhausted bulb is placed to serve as a kind of galvanometer; the brightness of the discharge is an indication of the strength of the current flowing round the coil. If I place a second conductor in the other loop, currents will be started in it and part of the energy of the discharge will be absorbed; this will leave less energy available for the bulb in the first, so that the discharge in this bulb will be dimmer. The effect produced on the discharge will depend upon the conductivity of the substance placed in the second loop. The effect is not directly proportional to the conductivity; in fact, a perfect conductor would not produce any diminution, nor would an absolute non-conductor. For a given period and with apparatus of given dimensions, there is a certain conductivity which gives a maximum effect; this follows easily from the theory of induction of currents, but at this late period in the evening I will take a shorter course and prove it by an experiment. I put a piece of brass in this loop, and you see it produces but a small effect upon the brightness of the discharge. Instead of brass, I now insert a plumbago crucible, which, though a conductor, is not nearly so good a one as the brass, and you see the discharge in the indicating bulb is completely stopped. I will now place in the second loop an exhausted bulb; you see it produces a decided diminution in the intensity of the discharge in the galvanometer bulb. I now replace the bulb by another of the same size containing dilute sulphuric acid; you see it does not produce nearly so large an effect as the exhausted bulb; this might be due, as we have seen, to the sulphuric acid being either too good or too bad a conductor. I can show that it is the latter by putting a bulb in filled with a stronger solution, which has a higher conductivity than the weak solution. If the smallness of the effect produced by the weak acid were due to its being a better conductor than the gas, then increasing the conductivity would still further diminish the effect of the acid; you see, on the contrary, that the strong acid produces a distinctly greater effect than the weak, hence the rarefied gas in the bulb is a better conductor even than the strong electrolyte. Let us consider for a moment the molecular conductivities of the two substances, the rarefied gas and the electrolyte. The pressure of the gas is about one-hundredth of a millimetre, while in the electrolyte there are sufficient molecules of the acid to produce, if they were in the gaseous state, a pressure of more than 100 atmospheres. Thus the conductivity of the gas estimated per molecule is about ten million times that of the acid; this is greater than the molecular conductivity of even the best conducting metals. If the pressure of the gas is diminished below a certain point, the conductivity begins to diminish. I have here an experiment which I hope will show this. The apparatus (Fig. 5) consists of two bulbs, one outside the other; the inner bulb contains air at a low pressure, while the space between the two bulbs is a very high vacuum containing practically nothing but a little mercury and its vapour. The amount of mercury vapour in this space is, at the temperature of the room, exceedingly small, but as the

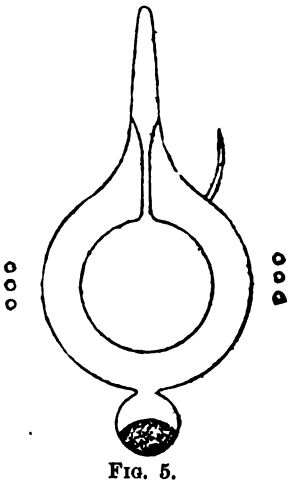

Fig. 5.

apparatus is heated the vapour pressure increases, and we are thus able to produce a fairly wide range of pressure in the space between the bulbs. The outer sphere is surrounded by the coil connecting the outer coatings of the two Leyden jars. When the space between the bulbs is a conductor, the alternating currents circulating in the coil will induce in this conductor currents whose inductive effect is opposite to that of the currents in the coil, and in this case this layer will screen off from the inner bulb the E.M.F. due to the alternating currents in the coil. If, on the other hand, the space between the bulbs is a non-conductor, the inner bulb will be exposed to the full effect of these forces. We now try the experiment: you observe

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that when the mercury is cold, and consequently the pressure in the space between the bulbs very low, a bright discharge passes through the inner bulb, while the space between the bulbs remains quite dark; when we heat the mercury so as to increase the pressure of its vapour, a bright discharge passes through the outer layer, while the inner bulb is quite dark. The outer layer is now a conductor, and by its action screens off from the inner bulb the induction of the coil.

The last experiment I have to show is one on the effect produced by a magnetic field on the discharge. When the discharge has to flow across the lines of magnetic force, the pressure of the magnetic field retards the discharge; when, however, the discharge flows along the lines of magnetic force, the discharge is helped by the magnetic field. This is shown in the following experiment: A is a bulb, B a

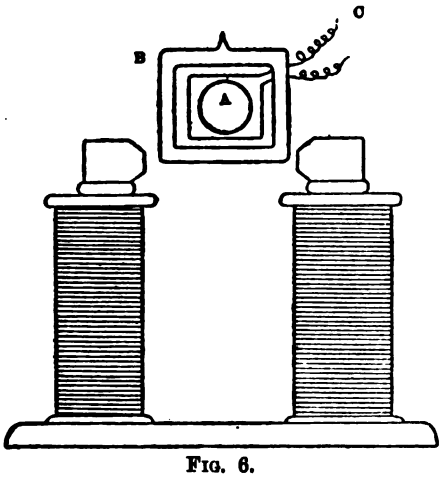

FIG. 6.

square tube (one side of which is placed between the poles of an electromagnet), the coil, C, which connects the outside coatings of the jars, can be adjusted so that when the magnet is "off" the discharge passes through the bulb, but not round the square tube; when, however, the magnet is "on," the discharge passes in the square tube, but not in the bulb. In the square tube the discharge passes along the lines of magnetic force and is helped; in the bulb it passes across them and is retarded.

A NEW MINING MOTOR.*

BY HENRY A. MAVOR.

(Concluded from page 107.)

Now, unfortunately, the substances which are suitable for insulating or confining the current to the conductors are none of them metals, and are not suitable for transmitting mechanical strain. It is for this reason that so much difficulty has been found in making motor armatures thoroughly sound in mechanical construction.

There is no doubt that experience has shown that the most satisfactory method of mounting the conductors is to place them in channels in the iron core as shown in Figs. 5 and 6. The common method of simply binding them to the smooth surface of the core has often led to trouble from the shifting of the conductors on the surface. That method would never have been adopted but for other difficulties, again electromagnetic as distinguished from mechanical, but which are fortunately rather a matter of ancient history than of practical present-day importance. There are other mechanical details applied to the construction of the motor which is more specially under our notice to-night which have done much to make the armature more satisfactory. Chief among these is the method of putting on the wire.

The usual method of winding such armatures is to start with a single conductor, and wind it by hand on the core from end to end. This is a most laborious process, which has the further disadvantages that the first turn of wire is covered up by all the succeeding turns, that the first turn to go on to the shortest, and the last the longest, no two turns being exactly the same length, while in the ends of the armature the wires are heaped up in a most unmechanical fashion. (The Gramme or ring winding is free from some of these defects, but has to be carried out entirely by hand.)

The method adopted in the machine under consideration is to wind in a separate former a coil for each slit in the core. These formers are wound in the lathe, and are all precisely similar in every respect. These separate coils are then set round the core, one in each slot, and are driven down to the bottom of the slot, one side of the coil half filling the slot, and the other side standing up above the periphery of the core. The projecting sides of the coils are then grasped simultaneously by a suitable tool, which keeps them in a fixed position, and the core is turned round through a half circle. The coils are thus twisted round, so that the projecting half comes to be diametrically opposite the half which has been embedded in the slot. The tool is then removed, and the projecting wires are slipped into the slots lying beneath them, and the main winding of the armature is complete, making a perfectly mechanical and symmetrical job, easily accessible for repair, and readily open to inspection. Two difficulties are thus overcome. A perfect positive mechanical drive is obtained for the conductors, and the mechanical difficulty of insulation is much reduced, because, instead of an indefinite number of possible points of contact between wire and wire, and between wire and core, we have a fixed number of places requiring protection, and these places are all in similar positions, so that the omission of the necessary protection can be determined by inspection. One of the chief difficulties to be overcome in all continuous-current electric motors is the tendency to spark at the brushes which transmit the current by the commutator to the moving conductors of the armature.

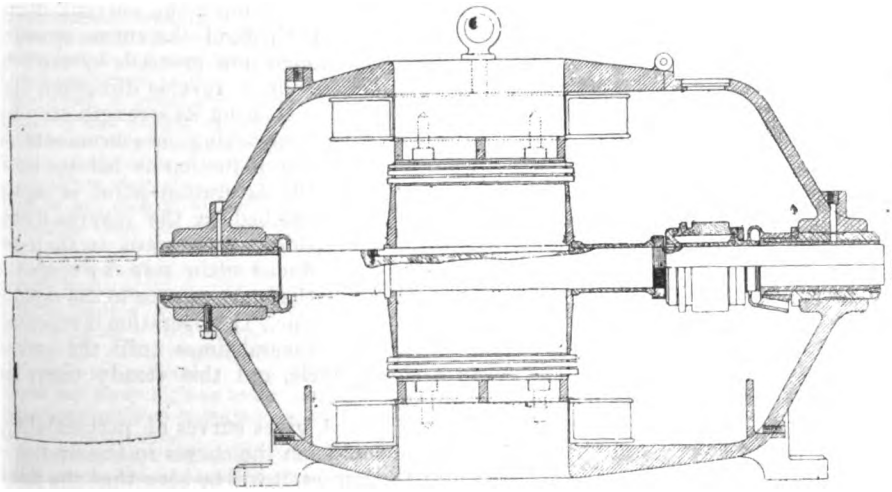

FIG. 5.—Longitudinal Section of Enclosed Type Motor.

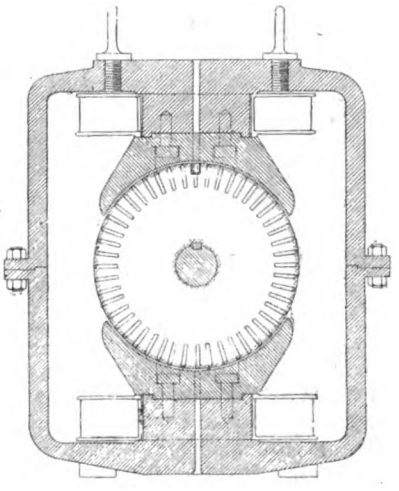

FIG. 6.—Cross-section.

* Paper read on December 18, 1894, before the Institution of Engineers and Shipbuilders in Scotland, and printed in the *Transactions* of the institution.

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Even in well-designed motors sparking is liable to occur with changes of load. This can be got rid of to a large extent by changing the position of the brushes with change of load, but it is not always convenient to do this, especially in motors used for intermittent work, such as hauling or coal cutting. A device invented by Mr. W. B. Sayers, and well known to electrical engineers, has, to a large extent, got over this difficulty, and experience in its use will probably enable motor-builders to design and construct motors of any size which will run sparklessly at any load without any necessity for changing the position of the brushes. The explanation of the action of this device is too complicated and technical for others than specialists in this work, and it will be sufficient to say that it has been successfully applied to machines up to the size of machine shown in the diagram, with perfectly satisfactory results as regards sparking, the brushes remaining fixed for all loads. Formerly considerations in connection with sparking fixed a limit to the air space or gap between the magnets and armature, so that this could not be reduced to the dimension otherwise desirable. The use of this device has enabled us to reduce the air-space to the very small dimension shown in the diagram. The effect of this shortening of the air-space will be at once evident from what has been said about the magnetic field—the intensity of the magnetic field, or group of magnetic whirls, set up by the conductors wound on the field magnets, depending on the nature of the substances which form its path. Iron increases this intensity, while air does not; therefore, the less air there is in the path, the less magnetising force will be required. This means that less current need be sent round the magnets, and, therefore, that less space is required for wire. It is this primarily which has enabled us to make a practical motor entirely enclosed in metal, and yet which is not excessively heavy or unwieldy. This has been made still more attainable by the advent of what is practically a new material. In the old days, cast iron was the material principally used for field magnets. The researches of Dr. Hopkinson and Mr. Gisbert Kapp demonstrated, without doubt, that dynamos ought not to be made of cast iron, and wrought iron for many succeeding years held the field. This is now destined to give way before steel, so called, which is really chemically pure iron, obtained by the process used for making steel. To enable me to illustrate the advantage of using this material, I will endeavour to give you a slight outline of the nature of the differences of these substances in the property of intensifying magnetic whirls, or stream lines, which, as we have seen, is an essential and vital element in the construction of dynamo-electric machinery. The diagrams which have been placed in your hands are intended to illustrate this property in different materials. See Figs. 7 and 8.

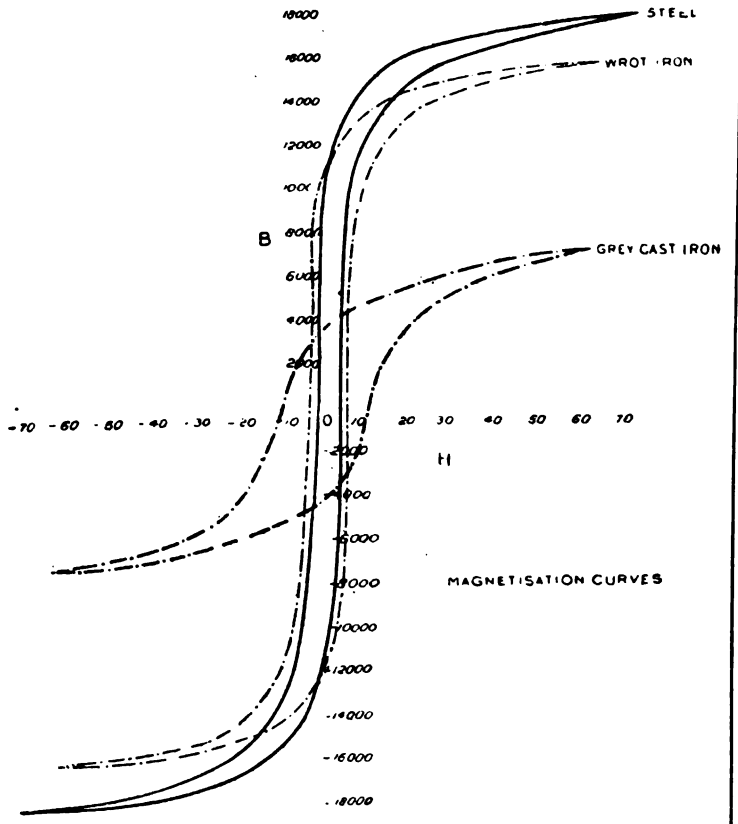

Fig. 7.

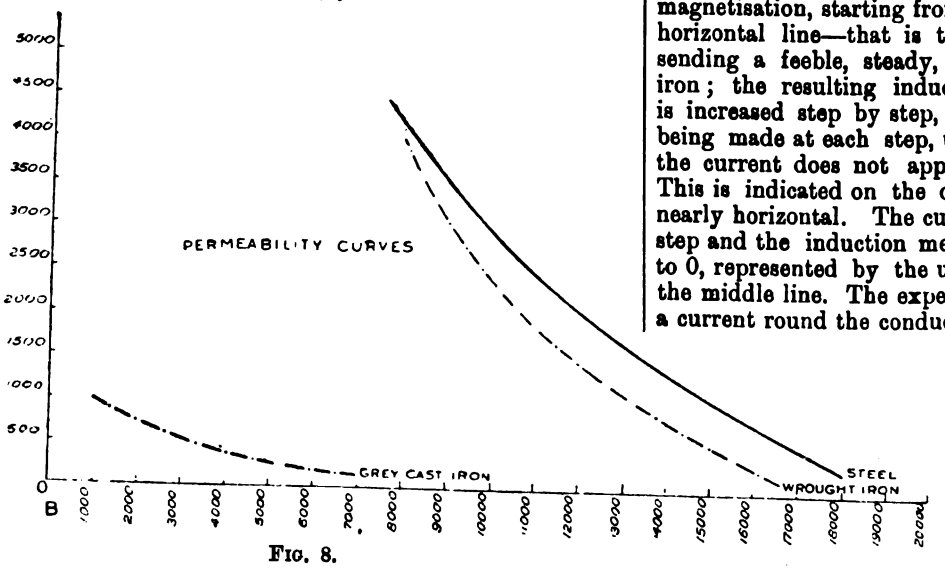

Fig. 8.

The two smaller curves, Fig. 7, are taken from those published by Messrs. Krupp. They are tests of grey cast iron and of wrought iron, which seem to have as good magnetic properties as any which have come under my notice. The largest curve, Fig. 8, is taken from those published by Messrs. Allen, of Sheffield, and is the result of independent experiments by Prof. Jamieson and Prof. J. A. Ewing, which are so nearly in agreement that the curves given by those two distinguished experimenters are practically identical.

The abscissæ, H, in this curve represent the magnetising forces produced by electric currents made to circulate in a conductor wound round the iron; the ordinates, B, represent the resulting magnetic induction. It will be seen that the curves are double, enclosing in each case an area.

The curve in each case represents a complete cycle of magnetisation, starting from and returning to the middle horizontal line—that is to say, the experiment starts by sending a feeble, steady, continuous current round the iron; the resulting induction is measured, the current is increased step by step, measurements of the induction being made at each step, until it is found that increasing the current does not appreciably increase the induction. This is indicated on the diagram by the curve becoming nearly horizontal. The current is then decreased step by step and the induction measured until the current drops to 0, represented by the upper part of the curve crossing the middle line. The experiment now proceeds by sending a current round the conductor in a reverse direction, and increasing its strength step by step, taking measurements of the induction as before until the saturation point is again reached in the reverse direction; the current is then reduced again step by step till the curve returns to the middle line. This operation is repeated several times until the curves settles down to a steady cycle, and this steady curve is shown on the diagram.

The other diagram, Fig. 8, gives curves of permeability, or the ratio, B/H, deduced from the curves in the first.

Looking, now, at the curves, it will be seen that the magnetising force, H, produces in cast iron a much smaller induction than in wrought iron or in steel; further, that the amount of induction, B, resulting from a given magnetising force, H, varies at the higher parts of the curve according to preceding magnetic condition in the cast iron very much more than in the wrought iron or steel; that wrought iron and steel are capable of magnetisation to a

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much higher degree; and again, that the energy required to produce a reversal of magnetisation in cast iron is much greater than in steel or wrought iron. All these peculiarities are disadvantageous, and, therefore, the use of cast iron for the parts of the motor subject to reversals of magnetisations has practically disappeared, and in all other parts has almost completely given way to wrought iron or steel. The steel has the special advantage that, while it has magnetic properties even superior to wrought iron, it can be cast into any desired shape and still retain its magnetic properties.

These considerations led to the adoption of steel for the magnets and case—the case also forming part of the magnetic circuit—of the motor in question.

B in the curves representing the induction per square centimetre of the metal, it will be seen that for a given total induction the steel need be much smaller in section than cast iron, and H representing the magnetising force per centimetre length, the reduction of magnetising force and consequent reduction of space for the conductor to carry the magnetising current, leads to a still further advantage.

It will thus be seen that the use of steel has not only increased the efficiency of the motor by reducing the necessary magnetising force, but by reducing the size and labour in tooling has also reduced the cost of production, while the use of a short air-space has made it possible to entirely enclose the motor without seriously increasing its weight. The enormous advantage of this will be at once apparent. Dust, damp, and explosive gases are entirely excluded from the working parts, while the increased radiating surface seems to compensate entirely for the less efficient circulation of air.

There seems every reason to expect that this machine has an important future in its application to mining.

DISCUSSION.

Mr. A. W. Stewart, who opened the discussion, thanked Mr. Mavor for the very lucid description he had given of his motor, especially to those who did not know much about the way the torque was given to the armature. He thought the description was one of the clearest he had ever heard. He asked Mr. Mavor if there was no trouble from sweat or moisture inside the shell. In a changeable temperature like a coal pit, a good deal of moisture would be dropping about the connections, and would develop short-circuits and other troubles. He would also like to ask him if he had tried anything in the way of alternating currents as applied to this motor. He understood that Mr. Brown, of the Oerlikon Works, had designed and had actually motors working now, called three-phase motors. These motors had no brushes or commutators, and worked with a very high efficiency, and so got over the difficulty that everyone who had worked with commutators must know about—the sparking of the brushes and the wear of the commutator. This was certainly a big step in advance to do away with commutators. Anyone who had been working with them knew that not only the wear of the commutator was a great nuisance, but also the breaking of the connections of the coils on the armature to that commutator. They gave incessant trouble in the best-designed motors.

Mr. Samuel Mavor said that with regard to the efficiency of transmission of power for colliery working the efficiency might be a very important point, but there were other considerations which were often a great deal more important than efficiency. The difficulty and danger of carrying steam down a pit and along the roads were very great; the loss was also very great, and there was always the trouble of keeping the joints tight, with the result that leaky joints were always in these pipes, and the roads were kept more or less choked with steam. The electric motor required less attention than the air or steam motors, so that in a pit where rope or steam transmission was used there were often small pumps where two, or three, or four men were working by hand, simply because the cost of the steam or rope transmission to those distant pumps would be so very great. One man paying the electric motor a visit on each shift for oiling was quite sufficient to keep the thing in good order, so that he might point out that although the efficiency for comparatively short transmissions might not be so high as some might expect, other considerations were frequently so important as to lead to the adoption of electrical transmission.

Mr. John Barr asked Mr. Mavor to state whether there was a small proportion of carbon in the field magnets, whether they were cast steel or hammered afterwards. The drawing showed a double brush where the spindle worked through the cast-iron casing, and he presumed it was made thus for replacement. He thought the efficiency of these motors was a very important point. It would be interesting if Mr. Mavor could tell them what ultimate efficiency he got, say, from a set of pumps driven by a motor in practical everyday work—*i.e.*, taking into account friction of steam-engine dynamo heads, motor, and pumps, leaving out the friction that might occur between the pump and the surface.

The discussion was then adjourned to the next general meeting

NEXT WEEK'S NEWS TO-DAY.

The Institution of Mechanical Engineers met yesterday evening for the reading and discussion of papers. The proceedings will be resumed this (Friday) evening.

A correspondent of the *Globe* writing from Gibraltar states that telegraphic communication is interrupted in Spain, as also on the Eastern Telegraph Company's cables to Tangiers and Cadiz.

The famous engineering works at Madgeburg, where electric motors are largely used, have just lost their principal in the person of Herr Gruson, who was yesterday reported to have died there on Wednesday evening.

Mr. James Bryce, the President of the Board of Trade, occupied the chair yesterday afternoon at the adjourned conference on light railways. The report of the committee, which is referred to in another column, was adopted.

An explosion is reported to have occurred at Dover yesterday (Thursday) morning in a transformer-chamber or junction-box. The explosion is attributed to an escape of coal gas. This report seems rather strange, seeing that the company have not yet commenced to supply light.

Dealing with the difficulty which has arisen in the law courts in regard to the positions and duties of some of the judges, the *Pall Mall* yesterday stated that "there is another aspect of the imbroglio which so far has been overlooked. Engineers, electricians, chemists, and others who have patent and technical cases to try, in short, scientific experts generally, are aggrieved that Mr. Justice Romer has been taken away from their work 'to serve tables,' so to say. They have the fullest confidence in him, and many declare that they prefer him without a jury to any tribunal in the kingdom. He seizes the point in a moment, measures the value of expert (that is, contradictory) evidence, and gives most lucid decisions—just what might be expected from an ex-Senior Wrangler. Litigants of the class referred to like a judge who knows, and who uses his knowledge, and is not afraid of giving a firm decision. His was the only equity court for the continuous trial of actions with witnesses—mostly of the expert class, who are now crying Ichabod."

Discussing the Great Northern and City (Electric) Railway Company's prospectus, the *Pall Mall Gazette* yesterday stated that, "It is not clear what arrangement, if any, the Great Northern Railway has made with the Metropolitan and North London Companies in connection with the formation of the new electric line, over which it will run trains from Finsbury Park to Moorgate-street. At present all its trains are run thither over the Metropolitan system, and for using that system the Moorgate-street and the North London system to Broad-street it pays these two companies about £25,000 and £30,000 a year respectively, varying with the traffic. The new line must divert an immense amount of this traffic, for a glance at the map will show that few passengers will care to travel from Finsbury Park to the City right round by King's Cross or right round by Dalston, when they can reach it direct by the new line. It looks as if a hole in the receipts of the Metropolitan and the North London must be made when the new line is used."

Electrical Engineer's Training.—The educational fad of the moment is electrical engineering, just as some years ago every man thought he must make his boy a civil engineer. Mr. James B. Cahoon, than whom there can be no better authority in the United States, tells us in the January number of *Electric Power* how this training must be supplemented in order to make a real electrical engineer. One important suggestion of Lieutenant Cahoon's is the training in moving heavy machinery into place.

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OVERHEAD WIRES.

Charles Kingsley is considered to have been an apostle of the bracing effects upon human beings of east winds, such as we know too well in the otherwise merry spring time. Doubtless there are those who enjoy the cold buffeting of Nature, just as many may be found hardy enough to break the ice for a morning dip; but when all is said and done, the fact remains that the strong alone can revel in hardships: the weak are generally shrivelled up. It is with no little pleasure that we can express absolute confidence in the electric traction interests so far as concerns their ability to withstand and ultimately overcome with ease the metaphorical cold blasts poured upon them just lately by the London County Council. The facts of the case are so clear, and the cause involved of such manifest justice, that the electric traction industry may well feel certain of successfully erecting the trolley wire, despite the opposition that is brought to bear from those who are either prejudiced or unaware of the true circumstances.

It is needless to attempt—in these pages—the least refutation of the statements made at the meeting of the London County Council on Tuesday last with reference to the application from the London United Tramways, Limited, for approval of an overhead wire system in the West of London. Every single one of our readers will recognise the ridiculous and childish nature of the objections raised—whether it be the absurd suggestion that the lines might be used to hang clothes upon, or would keep from the inhabitants of the district a large portion of the blue sky and sunshine for which London is so proverbially famous! How much difference can a quarter-inch wire make in any case?

We are not surprised at expressions of disapproval coming from many members of the London County Council, in view of the grandmotherly way in which Londoners were preserved from sky-signs that with all their hideousness were no worse looking than the average London chimney. It is charitable to hope that none of those who opposed the overhead wire proposal can ever have seen a trolley road of reasonable design at work, or listened attentively to promoters' statements, otherwise we should have to accuse them of absolute unfairness to a perfectly sensible method. It is not proposed, and never has been, that the exact trolley system as used in the United States shall come into employment here. Considerable improvements have been made in it which afford reliable grounds for stating that the overhead wire must be adopted or none at all. It is absolutely useless for the County Council to talk of electric traction as an excellent thing, but—overhead wires must not be employed. Alike on the score of cheapness in erection and working, they stand far above any other possible method of employing electricity as the motive power; and they afford all the advantages of low fares, rapid transit, perfect safety, and greater cleanliness, that are so desired and essential for modern requirements.

What, however, shall be thought of a journal like the *Pall Mall Gazette*—a paper that has done

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yeoman service in the exposure of electrical frauds—commenting upon the proposal above named in the manner that it does? The idea of "spoiling London streets by the erection of pillars and wires" is really too absurd for anything, even for a *Pall Mall* young man. We should like to find a single street in this London of ours where a line of tramway now runs that could in the least be rendered more atrociously hideous and ugly than it now is, thanks to the jerry builder and his *confrères*. If the *Pall Mall* wants to Hausmannize London, it should begin by taking the people further afield, by putting an end to the unhealthy and immoral crowding of families into small dens at fabulous rentals; then the buildings of the future may have a better appearance and do more justice to the metropolis not only of England, but of the world.

How can this better be done than by affording every possible means of rapid transit whereby the suburbs are rendered more easy of access, and the necessities of life—fresh air, sunshine, open spaces, and reasonable house accommodation at low rents—secured even to the poorest of the poor? Perhaps the London County Council or the *Pall Mall Gazette* will kindly answer our question.

LIGHT RAILWAYS.

The report of the Committee of Conference on Light Railways was issued yesterday (Thursday) afternoon. The report, which pressure on our space prevents publication in this issue, is accompanied by several appendices from individual members of the committee, although on the whole the committee are practically unanimous in their recommendations. The committee believe that the impediments to the construction of light railways may be greatly diminished, and that on a large proportion of such lines as are contemplated by their enquiry, the regulations which have been enforced with a view to public safety may be considerably relaxed. The committee state that the recent establishment of popular local authorities opens the door to an escape from the great cost attending applications to Parliament by enabling powers with reference to the authorisation and control of light lines to be conferred on those bodies. If this were done the committee consider that the initial cost of construction, and the expense of working, could be so greatly reduced that many light railways and tramways could be undertaken to the advantage of districts at present without satisfactory means of transport. Proposals for the construction and operation of such lines, the committee suggest, should be first submitted to the County Council. In conclusion, the committee express doubts as to whether it is desirable that local authorities should be empowered to contribute funds towards, or otherwise take part in, undertakings of this nature.

We understand that a Bill is very shortly to be brought into Parliament with a view to crystallising the results of the committee's investigations; and the probability is that substantial progress will now be made in traction matters, though not necessarily on a large scale at first, or on plans at all resembling those in vogue abroad.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC TRACTION.

SIR,—In a paragraph in your issue of last week on the recent discussion on "Mountain Railways" at the Institution of Civil Engineers, it is stated that at the meeting of January 22 several speakers referred to electric traction, and that one went so far as to maintain that electrical working ensured a saving of 50 per cent. as compared with steam locomotives, albeit, in your opinion, this probably only applies to cases where water power is available.

The two speakers who, during the whole discussion, referred more especially to electric traction were Dr. John Hopkinson and myself; and as it was I who made the statement quoted in your paragraph, I may say that the saving of 50 per cent., which I have over and over again proved in various papers and by comparisons founded on my own experience, is by no means limited only to installations driven by water power, but applies equally to cases where the dynamos are driven by steam-engines; and further, that it applies equally to steep-grade and to level lines.—Yours, etc., C. S. DU RICHE PRELLER.

18, Margaret-street, Cavendish-square, W.,
January 29, 1895.

ELECTRIC BRAKE COUPLINGS.

SIR,—Mr. Bushell's double-barrelled enquiry in your last week's issue is not very clear—is not, I may say, at all clear—and I would personally be glad if he can explain what it really is that he wishes to know. If he refers to the type of coupling required between adjacent carriages of a train fitted with any system of electric brakes, he need wish for nothing better than that employed on trains lighted by electricity. A simple spring jack-knife arrangement serves every requirement in this direction. If, however, he refers to the mechanical couplings which connect in some systems the magnetic braking device with the car axles or wheels, then he will need to specify which of these he has in view.

I can hardly suppose that he wishes to know the best coupling for ordinary brakes on electric railway trains, but his expression "electric railway brakes" is too indefinite to deal with as it stands.

The second part of his query is also very vague: there have been (I use this tense advisedly) as many electric traction companies as leaves in Vallombrosa. Which of them does he mean?—Yours, etc., FRANK B. LEA.

London, January 30, 1895.

AN ANGLO-AMERICAN CABLE.

In addressing the shareholders of the Anglo-American Telegraph Company, the chairman's remarks on the condition of these cables are reported as follows in the *Financial Times* of the 26th ult.:

"The 1873 and the 1880 cables were in fair condition, and the 1874 cable, which was repaired last year, was also in good condition, with this reserve, that it was interrupted in about 100 fathoms of water on the Irish coast."

In our last issue we published an extract from a Boston newspaper in which the 1874 cable is referred to, and from which it would seem that to look on this cable as in good condition (even while excepting the present break) shows a very sanguine temperament. For the benefit of our readers we reprint from the extract that portion which refers to the 1874 cable:

"In the meanwhile the 'Calabria,' double the size of

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us, had gone to repair the 1874 cable. She started in July, and was over 100 days at it. Once during that time she lifted one end, spoke the shore, and spliced one piece of new cable. When they commenced to pay out the cable broke, and, if my memory serves me right, it was on board ship. They lost it, and never recovered it again for that year. It sunk in 2,400 or 2,500 fathoms of water. There's one example for you. In October I was in St. John's and was ordered to proceed to England, I having told the manager that it was impossible to recover the cable that year. The 'Calabria' also went to England, the manager having agreed to what I said. All they had done was to break pieces off."

UNDERGROUND MAINS AT NOTTINGHAM.

In our issues of February 23 and March 2, 1894, we gave a description, together with several illustrations, of the central electric light station erected for the Nottingham Corporation between Talbot-street and Wollaton-street. The supply of light was commenced in September last, and since then the working of the station has proceeded satisfactorily.

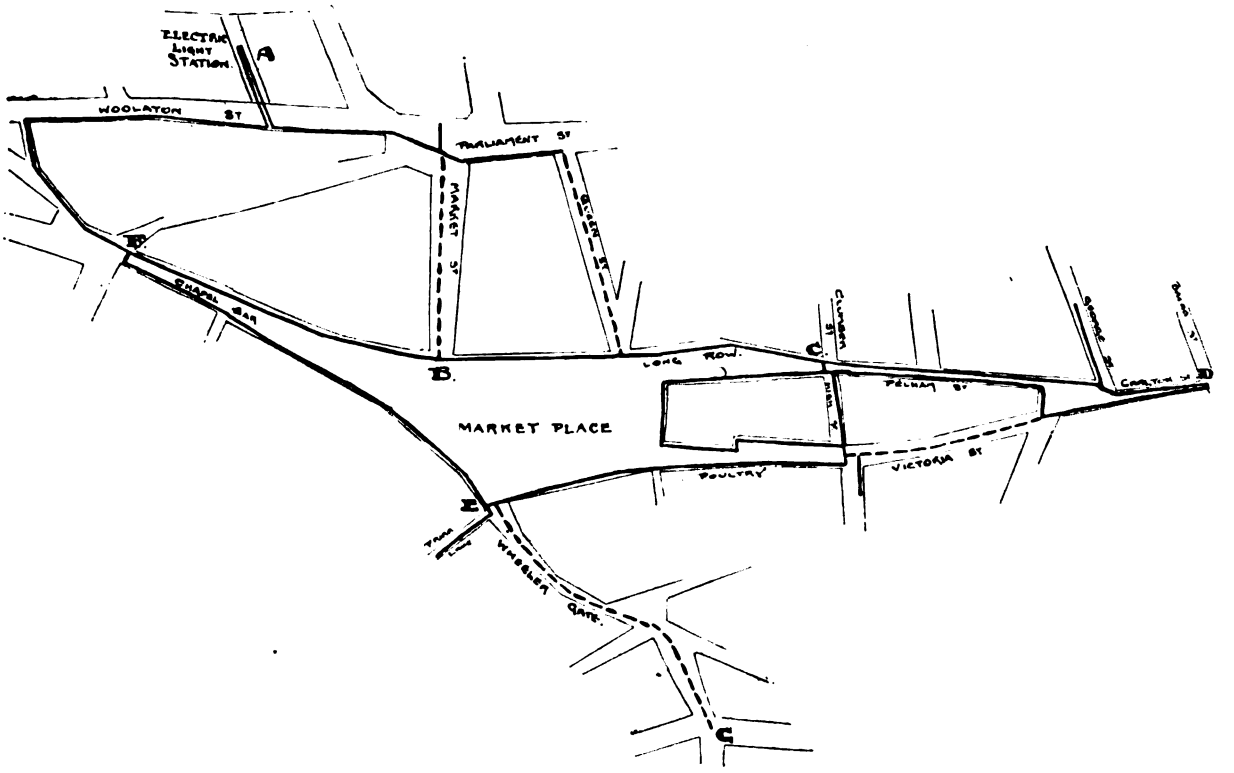

FIG 1.—Plan, showing in Continuous Lines where Conduits have been Laid, and in Dotted Lines the Subways containing Mains.

Some details concerning the underground mains will be interesting at the present moment, more especially as Nottingham is the first town in this country where any attempt has been made on a fairly large scale to utilise subways for the accommodation of the mains. It must not be inferred from this that all the mains are placed in subways. Some of them are carried in subways, whilst in other cases they are placed under the footpaths. The annexed plan, Fig. 1, shows the route followed by the feeders and distributors; Figs. 2 and 3 represent the laying of the conduits in different streets; and Fig. 4 shows the arrangement adopted of carrying the mains in the subways.

The contract for the whole system of distribution outside the station was placed in the hands of Callender's Bitumen, Telegraph, and Waterproof Company, Limited, of 101, Leadenhall-street, London, E.C. The specification provided that a drawing-in scheme should be used with cables on the three-way system, but it allowed great latitude in the choice of the details. After examining various offers the tender of the Callender Company was selected, and the system known as the "Callender-Webber conduit" was decided upon.

The Callender-Webber conduit consists of blocks of bitumen concrete made in 6ft. lengths and ways, varying in number and diameter to suit the requirements of the several lines. These cases are joined together on the work into continuous conduits, and access is gained to them for the purpose of handling cables (which are afterwards drawn in) from brick manholes. The diameter of the ways of the feeder casing is 3in. throughout almost the whole length, a few of the smaller sections having $2\frac{3}{8}$in. ways. The distributing network has ways of either 2in. or $2\frac{3}{8}$in., according to the size of cable employed. Spare ways have been left on each of the feeder lines, so that additional cables can be drawn in or new feeders can be provided to other points in the town when necessary. The casing throughout, both for the feeder lines and for the network, has been designed so that every way is large enough to take a cable of double the sectional area of that now drawn into it.

The brick pits are placed at each street corner so as to give immediate access to the cable wherever it is under the roadway, whilst others have also been constructed at different points under the footpath where they will be most necessary for drawing in the cable. Six extra large-sized manholes are provided at the points shown on the accompanying map, Fig. 1. These are used for the feeding points, and they have a clear opening of 24in. by 32in. Where the conduit has a large number of ways—*i.e.*, where the feeders and distributors run together—the drawing-boxes, of which there are 15, have a clear open space of 24in. by 18in. On the lines which consist only of distributing cables, the boxes, of which there are 40, are smaller, with 18in. by 12in. openings. All the boxes are provided with surface frame and a double cover, the inner cover being of cast iron, and so arranged as to form a watertight seal to the box. The outer cover is faced with concrete so as to resemble the paving in the adjoining streets. The pits are constructed of best wire-cut bricks set in cement, but the floor of the box is of loose brick rubble, so that any water which may by chance get into the pit will have every facility of draining away.

The adoption of this system does not necessitate arrangements being made for connecting services until they are actually required. Each individual customer is then easily connected with the mains, the casing being cut away and a small brick hand-hole built round it. These service-boxes have a frame and cover plate, so that the connections can be easily inspected.

At present, conduits have been laid in those streets shown by a continuous line on the accompanying plan. The

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dotted line indicates the subways in which mains have been placed. There being ample space in the subways, cast-iron brackets have been attached to the walls at convenient heights, and the cables have been payed into position and so held by bitumenised wooden blocks, which are gripped inside the brackets. The photograph of the subway shows the arrangement adopted.

The whole of the cables used are made as follows: The strand is of copper of 100 per cent. conductivity, tinned, and then stranded. It is braided with fine yarn and compounded, and is then insulated by means of a solid sheath of vulcanised bitumen put on at one operation under pressure. This core is twice taped, then served with yarn and well compounded, and finally braided with flax yarn and dressed with preservative material. The sectional areas of the feeders are

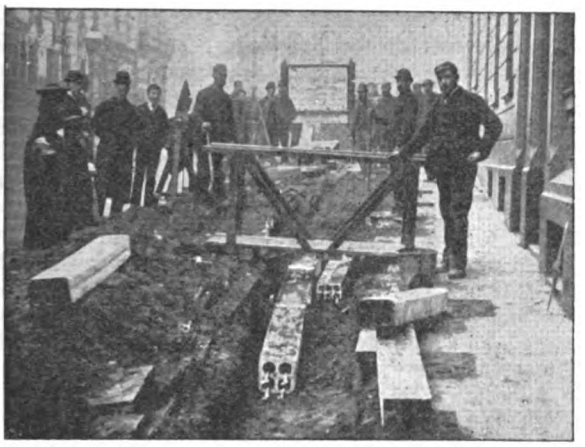

FIG. 2.—Laying the Mains.

·80 square inch, ·75 square inch, ·60 square inch, ·50 square inch, and a short line of ·25 square inch. The feeding cables to four of the feeding points consist of two outer conductors only, the connection between the third wire of the network and the generating station being made by the feeders at B and E only.

The distributing network consists of three cables, the centre wire being one-half of the sectional area of each of the outers, the largest of which consists of cables of ·25, ·125, ·25. In some of the heavier streets the sectional area is increased to ·30, ·15, ·30, whilst in some of the small lanes it is reduced to ·125, ·062, ·125.

FIG. 3.—Laying the Mains.

The total length of street in which mains have been laid is about 3,400 yards. In this distance there are 10¾ miles of case ways, and the accommodation in the subways equals 4½ miles of case ways. Into this about 10 miles of cable are joined together by copper bars at the various points where they interlace. These bars are so arranged that any line can be disconnected from any other with the greatest rapidity. The bars are insulated with bitumen compound, so as to prevent them from being influenced by damp or water. In addition to the main cables, pilot wires are provided from the station to each of the feeding points; these are separate vulcanised wires, each ·3, No. 18, on each pole, and that to each pole is drawn into the same way as the cable supplying that pole.

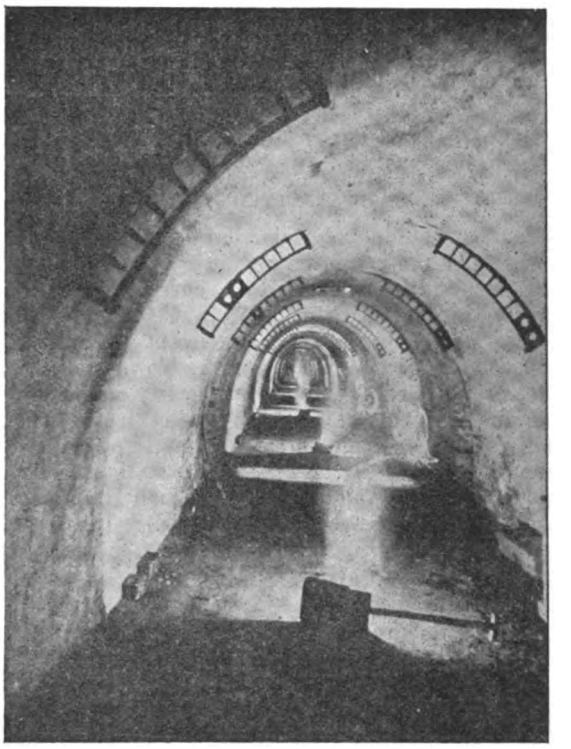

FIG. 4.—Arrangement of Mains in the Subway.

The contractors state that the plans were so carefully prepared by Mr. H. Talbot, the resident electrical engineer, that the quantity of casing and of cable used was found to tally with that estimated to within a few yards. No alterations whatever have been made in the original plans, but several extensions have already been necessary. The excavation of the trenches and the reinstating of the pavement were carried out by Corporation officials; but the whole of the other work was in the hands of the Callender Company, under the direction of Mr. Douglas Reid, their resident engineer, assisted by Mr. A. Burton. The station buildings, it may be mentioned, were designed by Mr. Arthur Brown, M.I.C.E., the borough engineer, and the electrical plant by Mr. Talbot, who also superintended the erection of the machinery.

WOLVERHAMPTON ELECTRICITY WORKS.

The ceremony of formally switching on the lamps supplied from the Wolverhampton electricity works was performed by Lord Kelvin on Wednesday afternoon. Among those present to welcome his lordship were the Mayor (Alderman C. T. Mander); Aldermen Saunders (ex-mayor), S. T. Mander, and Jackson; Councillors Jenks, Ironmonger, Pinson, McBean, Allen, Johnson, J. J. Tate, and Craddock; the Town Clerk (Mr. H. Brevitt); Messrs. Thomas Parker, A. B. Blackburn, J. Thompson, A. P. Brevitt (the architect), and H. Willcock (the builder). Mr. F. Harman Lewis, A.M.I.E.E., the borough electrical engineer, was, we regret to state, unable to be present, owing to an accident.

The station has been carried out according to the revised scheme prepared by Mr. Lewis, who was appointed electrical engineer to the Corporation in May, 1893, Mr. A. P. Brevitt, of Wolverhampton, being chosen as architect. It may be mentioned that Mr. R. E. W. Berrington, who is the borough engineer, reported on the subject of electric lighting two or three years previous to the appointment of Mr. Lewis. As a result of the advice given by Mr. Lewis, the Corporation in December, 1893, accepted the following tenders:

Buildings	H. Willcock and Co.
Boilers, economisers, and feed pumps.....	J. Thompson, Wolverhampton.

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Engines, condensing plant, dynamos and exciters, motor generators and switchboards	Electric Construction Company, London.
Mains	Callender's Bitumen, Telegraph, and Waterproof Works Company, Limited, London.
Arc lamps	Johnson and Phillips, London.
Lamp standards	Bailey, Pegg, and Co., Brierley Hill.
Accumulators	Epstein Electric Accumulator Company.
Overhead traveller	Bedford Engineering Company.
Water softener	Stanhope Water Engineering Company.

The Adopted System.

The system adopted is similar to that introduced at Oxford, with the exception that it is at 2,000 volts instead of 1,000. The high-pressure direct-current generating plant is erected in the station situated in Commercial-road, outside the area of supply. The current is transmitted at 2,000 volts to a switch station at the Town Hall, about the centre of the area of supply and nearly one mile distant, by means of trunk mains. At this centre the current is sub-divided by switching arrangements into smaller quantities, and conveyed by feeders to sub-stations. There are three sub-stations, one being at the Town Hall, a second at the Art Gallery, and the third at the Free Library. Motor generators are arranged in these sub-stations, transforming the current down to 110 volts.

The Station.

The station buildings occupy an area of 4,066 square yards, and the nature of the site selected will permit of extensions being made to nearly three times this area. The total area of the site is about 12,400 square yards, extending from the Birmingham Canal to the Commercial-road.

The boiler-house, which is 81ft. long by 50ft. wide, contains three Lancashire boilers, 30ft. by 8ft., fitted with Galloway tubes and Caddy's firebars, hand-worked. The pressure is from 120lb. to 130lb. per square inch. There are two Green's economisers, with extra foundations for an additional two, and two Cameron duplex feed pumps. The chimney stack, which is 120ft. high by 5ft. 6in. internal diameter, is capable of working five or six boilers equal in size to the present. The feed water is taken from the town mains, and is softened by being mixed with lime and soda, and then led into a cast-iron tank.

The engine and dynamo room is 79ft. 6in. long by 55ft. wide, and is spanned by a hand-worked travelling crane capable of lifting five tons. The plant installed consists of two 250-h.p. Marshall engines driving, by 15 1½in. ropes, two 132-kilowatt dynamos and their respective exciters, and one 125-h.p. Marshall engine driving, by eight 1½in. ropes, a 66-kilowatt dynamo and its exciter. A switchboard, of black slate panels, is provided in an oak frame, fitted with main switches and regulating resistances, and controlling devices for working the accumulators are placed along the top wall of this room.

The engines are of the horizontal compound-condensing type. Steam is admitted into the high and low pressure cylinders by Pröell's automatic trip valves placed upon the top of each cylinder, and in each case exhausted through Corliss valves fitted upon the under side of each cylinder. The automatic gear is controlled by Pröell's governor, which is extremely sensitive, being fitted with a speed-adjusting arrangement, so that the speed of the engine may be varied 5 per cent. either way whilst running.

The principal dimensions of the two 250 h.p. engines are: high-pressure cylinder 14½in. diameter, low-pressure cylinder 25in. diameter, and length of stroke 32in.; the flywheel is 14ft. diameter. The 125-h.p. engine has a high-pressure cylinder 10in. diameter, low-pressure cylinder 17½in. diameter, and a stroke of 24in.; the flywheel is 9ft. diameter. The dynamos and exciters are of the Elwell-Parker type.

The main steam-piping is 6in. wrought iron, with the necessary copper bends inserted, and valves of Hopkinson's double-faced slide type. The draining of the main pipe ring is effected by means of Royal's automatic steam-traps. The ring rests upon rollers, supported by standards in the boiler-house, and is suspended from brackets, by hangers, in the engine-room. The condenser is of the Ledward type, this being used with a centrifugal pump, coupled direct to the crank of a Chandler high-speed engine drawing its water from the canal. The circulating with the condensed water gravitates back to the canal. The steam has an alternative exhaust into the atmosphere 60ft. above the floor line. The cast-iron main exhaust is 14in. diameter, and is placed in a trench below the floor line, and is covered over with chequered plate.

Sub-Stations.

A sub-station and a central switch station combined are arranged at the Town Hall. It contains two lighting transformers, an arc-lighting transformer, and a battery-charging transformer. The switchboard has black slate panels arranged in an oak frame and fitted with switches, resistances, and automatic devices for working the distant sub-stations, home transformers, mains, and regulating the batteries.

The Free Library and Art Gallery sub-stations are each equipped with one lighting transformer and automatic switch controlled from the central switch station. Each sub station is fitted with a small two-ton travelling crane.

The Mains.

The high-pressure trunk and feeder mains are laid in cast-iron troughs, being supported from the metal by wooden bridges, and then completely surrounded by bitumen run in hot. The method adopted is Callender's solid system. The arc light concentric telephone and pilot wires and the distributors are lead covered and steel sheathed, and laid direct into the ground. The length of the mains is nearly one mile of high-pressure trunk main, one mile of high-pressure feeder main, two miles of arc light concentric, and over 2½ miles of low-pressure distributor for consumers' lighting.

Up to the present, 59 applications for the supply of electrical energy, representing 4,161 8-c.p. lamps, have been received. The total cost of the undertaking has been £25,019.

THE INCANDESCENT LAMP.*

BY MANNING K. EYRE.

To describe at short notice for the non-technical reader and in a limited space the manufacture of incandescent lamps is not as simple a task as may appear, and I therefore beg the forbearance of the reader if the result proves, as I fear it may, uninteresting and incomplete.

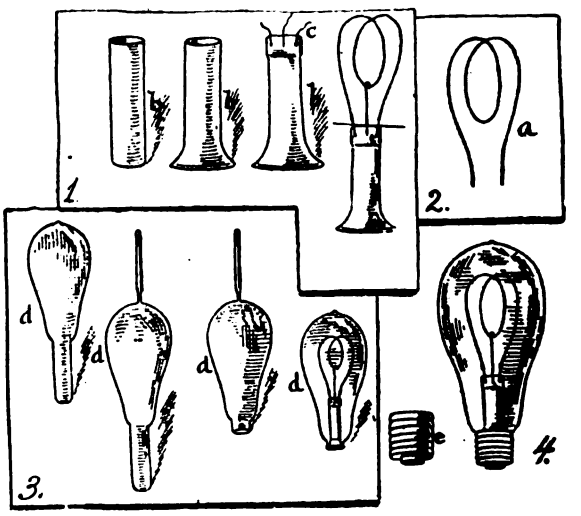

FIG. 1.—Part of an Incandescent Lamp.—1. Showing Steps in Manufacture of "Inside Part."—2. Filament.—3. Showing Steps in the Manufacture of Bulb.—4. Base and Finished Lamp.

The manufacture of incandescent lamps consists in the manufacture, manipulation, and final assembling of the five distinct parts which constitute a finished lamp. The total number of operations necessary in the construction of the lamp is in the neighbourhood of sixty-five. It is needless to add that in the space of this paper it is not only impossible to fully describe any process, but many of them

* The *Electrical World* (New York).

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can only be indicated. The five parts of the lamp above referred to are, *a*, the filament; *b*, the inside part; *c*, the leading-in wires; *d*, the bulb; and, *e*, the base. These appear in Fig. 1, and are there indicated as *a*, *b*, *c*, *d*, *e* in the order named.

The filament, or, as it is commonly called, the carbon, is that part of the lamp which in offering a resistance to the passage of the electrical current is thereby rendered incandescent, and emits heat, which is waste, and light, which is useful. The history of the development of this insignificant-looking thread is the history of some of the best years of such men as Gaudoin, Swan, Sawyer, and Edison, and a host of others. The first filaments used with any success were made of platinum, but as this fused at a temperature a trifle above white heat, it was exceedingly unreliable. Below white heat it gave insufficient light, and above this point it soon melted. It was evident that some substance was required that could stand considerable variation of temperature without danger of fusion. Carbon possessed this quality, and various vegetable substances, containing a high percentage of carbon, were tried with more or less success—such as silk threads, cotton, jute, sugar, paper, and bamboo. The latter is probably the best natural product for the construction of a filament, and when carbonised and treated properly results in a highly satisfactory and efficient lamp.

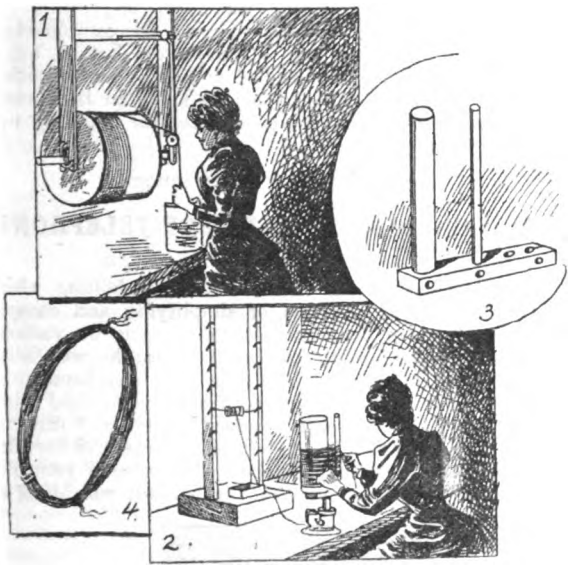

FIG. 1A.—Manufacture of the Filament.—Winding the Filament.—2. Shaping Oval Filament.—3. Spiral Form.—Coil of Filament.

To obtain uniformity of structure and a homogeneous product, manufacturers have experimented with liquid compounds, eliminating air-gaps. The mixtures used are numerous, being the combination of some vegetable fibre with an acid or a salt, as, for instance, the combination of cotton, wood pulp, or silk with sulphuric acid or chloride of zinc. The base and acid are placed in a vessel and thoroughly stirred by means of a rotating spindle provided with paddles until the base is thoroughly mixed. It is next placed in bottles, the liquid being about the consistency of thick molasses, and forced out of the lower ends of the jars through small dies of various sizes, representing the cross-section necessary to make filaments for the different candle-powers and voltages. After the squirting process the fibre is solid, and after being thoroughly washed and purified is wound on drums, shown in Fig. 1A. This is the first step in the operation of drying the filament. Only one layer is reeled on the drum, the drum as it rotates moving horizontally, so that the successive turns cannot fall one on the other. When removed from the drums it is wound on a loose coil, and the two ends of the coil measured with a micrometer. This measurement serves to indicate the particular class of the lamp the fibre is destined for, and consequently which particular form of mandrel it shall be shaped upon.

Another method of attaining the same object consists in using two drums, winding the fibre from one drum to the other. In this case the fibre passes through guides, placed between the drums, which lead the fibre through an acid while in transit.

At the lamp works of the General Electric Company three forms are used for shaping filaments—the oval, for all high-volt low-economy lamps; the spiral, for high-volt 16-c.p. high-economy lamps; and the horseshoe, or loop, for low-volt lamps. The low-volt low candle-power lamps require too short a filament to admit of the use of a spiral or oval. The coil taken from the drum is then wound on the proper form, sometimes called a mandrel, to shape it for the style of lamp desired. The oval and spiral forms are shown in Fig. 1A, the operator being shown in the act of winding the fibre on the oval form, which consists of two vertical rods, the cross-section of one being an ellipse, the other circular. The fibre is wound with one complete turn around the elliptical and half a turn around the cylindrical rod.

The next step in the process of manufacture is the carbonisation of the fibre. A moderately complete description of this process, as carried out by some manufacturers, may be found in Mr. Gilbert S. Ram's work, entitled, "The Incandescent Lamp and its Manufacture." Briefly stated, it amounts to this. The fibre is wound on carbon blocks of the desired shape, but in order to allow for the shrinkage of the fibre, which is very great, the two carbon sections of the form are connected by means of wooden sticks. As the process of carbonisation proceeds the sticks shrink with the fibres, so that at the end of the process the two carbon blocks are in contact. These blocks are packed in a carbon box, about 10 in a box, leaving enough space for the blocks to move freely in the shrinking process. Between each block is a thin partition of carbon, which slides loosely in the box. The carbon box, containing the forms, is then placed in a plumbago crucible, leaving some clearance all round, which is filled up with powdered charcoal. The heat of the furnace into which the crucibles are packed should be very gradually raised, eight hours being about the time required for the first heat (about 600deg. C.). About five or six hours more brings the temperature to a bright red, and an additional three or four hours to a white heat. Whatever the process, we will suppose the fibre carbonised and cut into proper lengths, each length representing a filament as it appears in the finished lamp. Measurements are again taken with a micrometer of each individual filament, which are then sorted out into proper boxes for transfer to the treating-room. If the two ends of the filament do not measure alike, the carbons are rejected. It is to be regretted that there is no space for details, as in a great measure it is the details which would convey to the reader some of the real difficulties of lamp manufacture. For instance, in the handling of the fibre the greatest care must be taken to regulate the shrinkage. A filament squirted with a diameter of 22 mils may after drying be reduced to 10 mils, and again after carbonisation to five mils—a total difference of 17 mils. Now, bearing in mind that with two finished filaments of the same length a difference in cross-section of one mil makes all the difference between a 16-c.p. and a 20-c.p. lamp, some of the trials and tribulations of manufacturers may be understood.

The object of the next process, treating the filament, is, briefly, to give it a uniform and homogeneous surface. Up to this point, no matter what the process adopted and in spite of every care and precaution, the filament is still in a more or less crude state. In all the early filaments the fibrous structure was porous and irregular. The effect of this can be readily conjectured. Each filament consists of an infinite number of small fibres, unsymmetrically arranged, and the electrical current, finding no continuous path, is compelled to jump from fibre to fibre. This forms a succession of infinitely small electric sparks, which (though we may not see them) tend to disintegrate the filament and make a short-lived lamp. The use of a liquid instead of a solid, the quality of the mixture, and, in general, the superior methods of manufacture now employed, render the filament as it now arrives at the treating stage more uniform, and with its porosity and irregularities reduced to a minimum. Nevertheless, it would be far from satisfactory without this treatment. Years ago filaments were manufactured stamped out of paper, carbonised between sheets of paper in moulds, and then

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treated with a carbon gas. Gasoline vapour has been very usually employed, or any hydrocarbon gas.

The treating apparatus consists, in brief, of two jars provided with tight stoppers, a galvanometer, rheostats, and circuit breaker. Fig. 2 shows an operator holding in her hand the stopper of one of the jars, the necks of which only are visible. The two projections on the stopper are holders for the carbons. The carbons having been placed

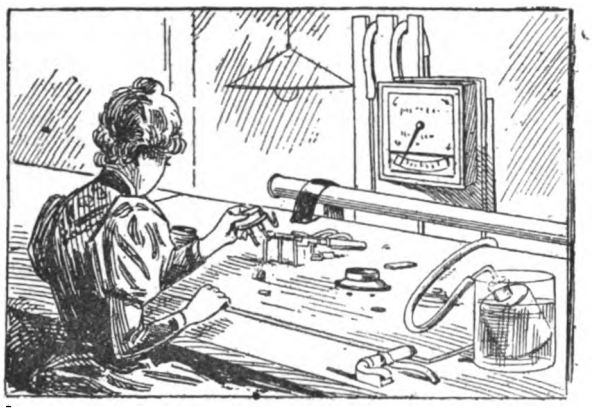


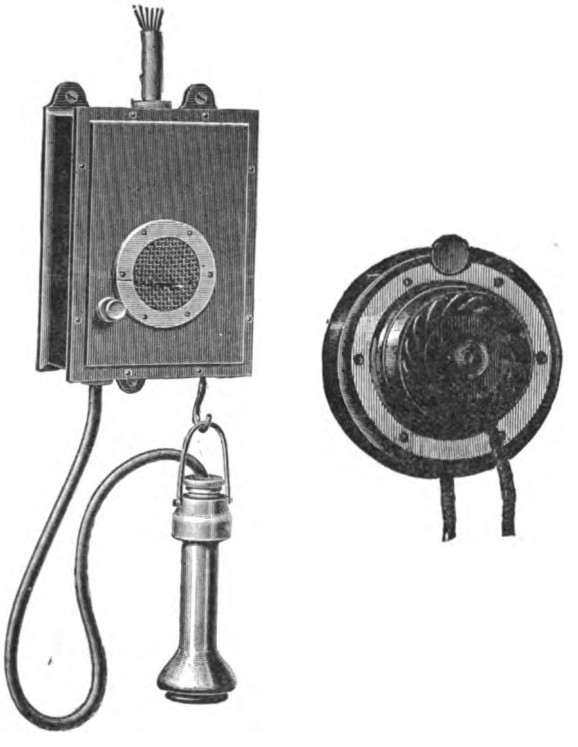
FIG. 2.—Treating Process.

in the holders, the necks of the jars are closed and the circuit is made. The gas in the jar deposits the liberated carbon on the filaments, making a surface of uniform resistance. Since this deposit adds to the surface of the filament it must add to its diameter, causing a considerable reduction in the resistance. The specific resistance of the deposit is also considerably less than that of the filament.

(To be continued.)

MINING AND ENGINE-HOUSE TELEPHONE.

A novelty in the way of telephony has been introduced in the form of a mining and engine-house telephone. This instrument, which has been brought out by the General Electric



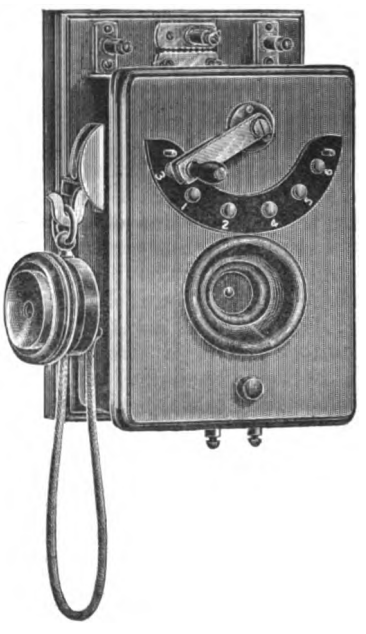
Company, Limited, of 69 and 71, Queen Victoria-street, E.C., has been devised to meet the demand for a good serviceable instrument which will stand a large amount of rough use, and at the same time be practically impervious to injury from moisture, dust, etc. These causes of danger to the proper working of telephones are experienced in mines, engine-houses, engineering works, etc., and the company consider that their mining and engine-house telephone is so constructed as to be unaffected by any of these causes.

The containing case consists of cast iron, with the front screwed on with indiarubber packing, between the sides and front of case. Special precautions have been taken so that no moisture can be admitted through the mouthpiece of the transmitter, or at the point through which the switch-hook enters the case. The receiver is constructed of gunmetal, and is a solid and substantial piece of work, calculated to stand any amount of rough usage without being broken or injured. The flexible cord which connects the receiver with the containing case is protected by a steel flexible tube, which passes through a stuffing-box into the interior of the case at one end, and into the interior of the receiver at the other end. The whole of the movement inside the containing case is mounted on an ebonite slab, so that the working parts are thoroughly insulated from the metal case. The company believe this instrument will be invaluable to colliery proprietors and others who have hitherto been unable to avail themselves of the convenience of a telephone, owing to the difficulty of obtaining an instrument which would stand the wear and tear to which it would be subjected. The "Hunningscone" transmitter "is used, and is a sufficient guarantee that the speaking is both loud and clear, this transmitter still holding its own on the market.

The General Electric Company inform us that they have recently taken over the business of the Anders Telephone Company, and that they are now selling the Anders telephone for domestic purposes under the name of the "Stanley" telephone. This instrument can be readily attached to existing bell wires, and will be found to give great satisfaction. The price is such as places it within the reach of most householders who would have a use for the telephone. The wall-pattern instrument which the company are selling does not exceed 4in. in diameter, and is made in an artistic design, which readily adapts it for being fixed in drawing-rooms, dining-rooms, libraries, etc. The original intention of this combination was that it should supersede the ordinary press button, but it is equally applicable for commercial purposes, being both loud and distinct. The instrument is also made in the form of a small pedestal, which is very convenient for standing upon a desk, table, or mantelshelf.

"RETIRING HOOK" SYSTEM OF TELEPHONES.

The "Retiring Hook" system of telephones, which is another step in the direction of simplifying and cheapening intercommunication between different rooms or stations in large buildings and institutions, such as warehouses, factories, suites of offices, or on private estates, has been brought under our notice. The name is derived from the method adopted, so as to avoid the annoyance caused in other "direct-call" systems by the switches being left as last used, either through carelessness or through the springs which should return them failing to act, and thus preventing another call from being made.



In these instruments the receiver-hook disappears into the instrument as soon as the switch is moved and the receiver taken off, and the operator can therefore not hang up the receiver again until the switch has been put "home." The simplicity of the instrument makes it not only workable, but cheap. The makers, Messrs. Gent and Co., of Leicester, have had considerable success with their intercommunication sets since they took up the sole manufacture of Sloper's instruments, and this adds another to the variety of telephones they manufacture.

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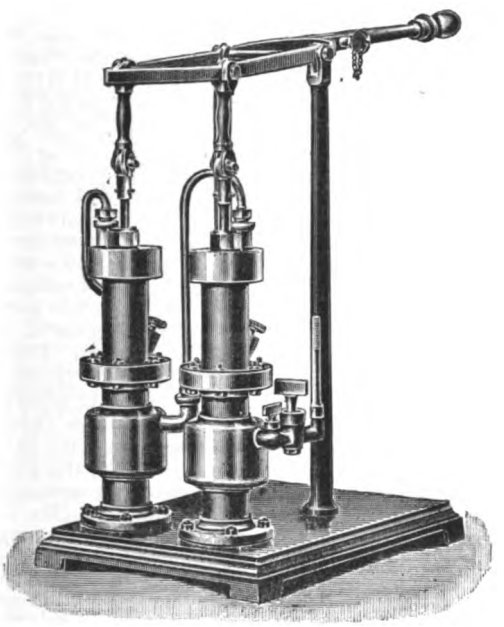
THE GERYK VACUUM PUMP.

It is well known that the tediousness of obtaining a good vacuum has very largely prevented scientific men from investigating the behaviour of various materials *in vacuo*. The difficulties attending the performance of these experiments are the more to be regretted, because, as Prof. Crookes has pointed out, the investigations must prove of value to chemists in the study of several rare cactus and of the many substances which exhibit the property of phosphorescence *in vacuo*. To the electrician the matter is of no less importance whether in the exhaustion of Geissler tubes or of incandescent lamps.

The Geryk pump, here illustrated, whilst giving quick exhaustion, produces a vacuum equal to that obtained by the Sprengel or other mercury pumps. The pump shown in the illustration is a small hand-pump for laboratory use.



The pump may be described as working on the hydraulic principle, but with specially prepared oil practically free from vapour tension. There is no clearance, and it is absolutely positive. This pump has been tested by some of the leading scientists in this country. A small pump, worked by hand, was shown at a recent meeting of the Royal Society and Royal Institution. Geissler tubes were there exhausted in about 70 seconds, which by the ordinary process of exhausting by mercury pumps would have taken an hour. The total stoppage of the spark in the tubes was obtained in a little longer period. These and similar results show that the Geryk pump is capable of doing good work as regards fineness of vacuum. It can be made in any size, and we are informed that the makers, the Pulsometer Engineering Company, Limited, of Nine Elms Ironworks, London, S.W., have supplied them of a capacity of 100 cubic feet per minute. These should prove exceedingly useful to incandescent lamp makers; in fact, the advantage of large pumps producing such a high vacuum can scarcely be over-rated. The makers state that lamps exhausted by these pumps without the aid of mercury pumps are giving first-class results.

PHYSICAL SOCIETY.

At the ordinary meeting on 25th ult., **Mr. Medley** concluded the reading of a paper by Prof. Ayrton and himself on "**Tests of Glow Lamps**," which was commenced at a former meeting. With the newer lamps employed in these tests, it was found that candle-power, current, and candles per watt all rose as the lives of the lamps increased. The authors, being surprised at this result, took care to satisfy themselves that the effect observed was due neither to change in the resistance of their manganin potentiometer strip, nor to uncertainty of contact at the sockets of the lamps. Starting again with new lamps, they found that in all cases the light given out was greater after the lamps had been glowing for some time than it was when they were new. In the earlier tests a considerable falling off in candle-power had always taken place after the lamps had been running for some time Further, while the globes of the earlier lamps were always much blackened, even after a run of a few hundred hours, and so became comparatively useless long before the filament broke, the Edison-Swan lamps now examined showed hardly any blackening, even when the filaments lasted over 1,300 hours. The rise in candle-power was always accompanied by a rise in current, which was, however, proportionally much smaller, so that the consumption of power per candle was actually less after the lamp had been running 50 hours than it was at the beginning. Among the conclusions drawn by the authors were the following: (*a*) when a group of Edison-Swan lamps marked 100-8 are run at 100 volts, and each lamp as its filament breaks is replaced by a new one, it may be expected that the light given out will never subsequently be as small as when all the lamps were new; (*b*) an Edison-Swan lamp marked 100-8 when run at 100 volts will give an average illumination of about 10 candles, and will absorb on an average power of about 4·3 watts per candle, so that such a lamp must be regarded as a 43-watt lamp, and not a 30-watt lamp, as is frequently stated; (*c*) the maximum rise of light recorded during the life of any lamp was 45 per cent.; (*d*) with lamps of the type examined there is no point at which it becomes economical to discard a lamp before its filament actually breaks; (*e*) no marked economy can be gained by over-running such lamps – *i.e.*, by using pressures exceeding 100 volts.

Prof. Ayrton mentioned that the improvement in incandescent lamps after running for some time had been attributed to an improvement in the vacuum. Experiments made on new and used lamps by means of an induction coil showed that the more a lamp was used the better the vacuum became, but he (Prof. Ayrton), though at first inclined to adopt this explanation, had since found that, though in all the lamps examined the progressive improvement of the vacuum was equally marked, the increase in candle-power varied between very wide limits, being very considerable in some lamps and hardly perceptible in others.

Prof Rucker asked if it made any difference to the life of a lamp whether it were kept running continuously until the fibre broke, or were run for periods of a few hours, alternating with intervals of rest? The latter case would more nearly correspond with the conditions obtaining in practice

Prof Ayrton replied that the lamps were kept running during the night and were disconnected during the day.

A paper by **Prof. Anderson** and **Mr. J A. McClelland**, "**On the Temperature of Maximum Density of Water and its Coefficient of Expansion in the Neighbourhood of this Temperature,**" was read by the secretary, Mr. Elder The dilatometer method was used, but the bulb of the instrument contained a quantity of mercury, determined by experiment, which, for the range of temperature concerned, was such as to secure the constancy of the remaining internal volume occupied by water. The observed changes were thus the real and not the apparent changes. The bulb was furnished with a graduated tube of small bore, bent twice at right angles, which served at the same time the purpose of a ground-glass stopper. (The joint was made watertight by a little Canada balsam.) To determine the coefficient of expansion of the glass, the bulb and tube were filled with mercury at 0deg. C. and heated up to about 9° 7 C., the necessary weighings being afterwards performed. The coefficient of expansion of mercury being known, the number of grains of mercury to be kept in the bulb during the experiments on water was calculated. The dilatometer was next filled with (thoroughly boiled) distilled water at about 8deg. C, the stopper end of the graduated tube inserted, and the free end dipped under mercury, giving at 4deg C. a column of mercury whose changes of level could be observed. A thermometer was placed with its bulb close to the middle part of that of the dilatometer, both being immersed in a water bath which could be cooled by the addition of ice cold water or cooled by radiation from surrounding objects. The thermometer used was graduated to tenths of a degree, and was compared with two similarly graduated ones by different makers. The two latter agreed very closely with another, and one had a Kew certificate showing no error in the readings. Temperatures were written to the fourth decimal place, but accuracy to this extent was not claimed. Three sets of experiments were made, and for each a corresponding curve was drawn. In the first the water was at atmospheric pressure; in the other two, at one and a half and two atmospheres respectively. Corresponding to these three pressures the temperatures of maximum density found were 4°·1844 C., 4°·1823, and 4°·1756 The value 4°·1844 corresponding to atmospheric pressure is greater than that generally received.

Mr. Rhodes thought that sufficient precaution had not been taken to accurately calibrate the thermometers. He doubted whether temperatures read in the manner described could be relied upon to much less than 0·1deg. He did not see that any real advantage was gained by having mercury inside the dilatometer to compensate for the expansion of the glass.

Mr. W. Watson thought that the mercury within the vessel would cause further uncertainty by tending to produce distortion of the glass. He pointed out that in the case of water at maximum density there would be practically no convection currents, so that equalisation of temperature would be very slow. As the bulb used was about 8cm. in diameter, and all the experiments were made with the temperature rising, he thought that this would account for the high value obtained for the temperature of maximum density.

Dr. Burton thought a distinct advantage was gained by compensating for the expansion of the glass. The values obtained in different experiments did not seem to be highly concordant.

Prof. Rucker thought that the criticisms which had been passed were for the most part just. For such measurements as those recorded it was not sufficient to know the corrections of the thermometer readings at a few isolated points; the portion of the stem over which the readings were taken must be carefully and minutely calibrated. The Kew certificate not only ignored errors of less than 0·5deg. (as mentioned by the authors), but it only gave corrections for a small number of temperatures separated by considerable intervals.

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THE PROJECTED ELECTRIC TRAMWAY AT ACTON.

The Highways Committee of the London County Council presented the following report on Tuesday in regard to the proposed electric tramway to which we have previously referred :

We have considered the application made by the London United Tramways, Limited, which has acquired the undertaking of the West Metropolitan Tramways Company, for the Council's consent, under the latter company's order of 1887, to the use of electricity by means of overhead wires as the motive power for working so much of the tramway in Uxbridge-road, between Shepherd's Bush-green and Acton, as is within the county of London. We have in connection with this matter received deputations from the Vestry of Hammersmith, the road authority of the district, and from the company concerned, in support of the application. The company states that the proposed system is in operation in the most fashionable streets and boulevards in Brussels, Genoa, Florence, Havre, and other important continental cities and towns, and is about to be adopted on some of the tramways at Bristol. The system involves the placing in the centre of the thoroughfares of columns with brackets, with bare copper wires stretched between them; and, having in mind the very decided opinion expressed by the Council some time since against the proposal to adopt the road-centre lamp system for the electric lighting of the Victoria-embankment, the system proposed by the company is, we think, not likely to find favour with the Council. The company urges in support of its proposal that these columns would be of an ornamental character, and could, moreover, be used for the street lanterns ; but we are very doubtful as to the benefit to be derived from such an arrangement. Having regard to the policy which the Council has always adopted with respect to overhead wires, it appears to us most unadvisable that it should consent to the adoption, in any part of London, of a system involving the use of overhead electric wires for working tramways; and it is to be borne in mind that, should the Council consent to the adoption of such a system for tramway purposes, there would probably arise immediately a demand on the part of electric lighting companies to be allowed to place their wires overhead also, especially as no reason can be alleged against the adoption of that course which would not apply with equal force to the tramway wires. We recommend that the consent of the Council be not given to the use by the London United Tramways, Limited, of electricity by means of overhead wires as the motive power for working the West Metropolitan Tramway in that portion of the Uxbridge-road which is within the county of London ; and that the Board of Trade and the London United Tramways, Limited, be informed of this decision.

The committee's recommendation was opposed by Mr. Beachcroft, who proposed as an amendment that the necessary permission should be given. In this he was assisted by the Rev. Fleming Williams. Mr. J. Williams Benn, M.P., and Mr. John Burns, M.P., supported the committee. Ultimately the amendment was rejected, and the committee's recommendation was approved.

THE TRANSFER OF THE TELEGRAPH SYSTEM TO THE STATE.

The twenty-fifth anniversary of the transfer of the telegraphs to the State was commemorated by a dinner, held on Monday in the Whitehall Rooms of the Hôtel Métropole, under the presidency of the Postmaster-General (Mr. Arnold Morley). A card, bearing the dates 1870-1895 and portraits of the 10 Postmasters-General of the quarter of a century, was placed before each guest. Below these were representations of her Majesty's cableship "Monarch" and of a field-service van, and portraits of the late Mr. Patey, Mr. Scudamore, and Mr. Baines. The portraits encircled some statistical information as to the progress of the telegraphs in 25 years. The telegrams—inland, Press, and foreign—have risen from 6,830,000 to 71,465,000, the mileage of line from 14,776 to 32,881, the mileage of wire from 59,430 to 206,304, the instruments in use from 670 to 8,500, the number of words per minute capable of being transmitted on the fastest form of instrument from 70 to 600, and the offices from 2,932 to 9,637 ; and the average charge for ordinary inland telegram has been reduced from 2s. 2d. to 7¾d. The wires were all worked on the simplex plan 25 years ago ; now the processes are simplex, duplex, quadruplex, and sextuplex.

A telegram from Copenhagen was received on Monday by the Postmaster-General from the Great Northern Telegraph Company tendering congratulations on the occasion of the twenty-fifth anniversary of the transfer of the British telegraphs to the State. That company being the only foreign telegraph administration which has enjoyed the privilege of working in connection with the General Post Office on British soil during the whole of that period, they felt called upon to bear testimony not only to the marvellous progress made by the Government telegraph service, but also to express their sincere appreciation of the hospitality and goodwill shown to their company and staff.

The CHAIRMAN, in proposing "The Queen," said that in July, 1837, the first practical working telegraph was constructed by Mr. Wheatstone on the London and North-Western Railway between Euston and Camden Town. In 1851 Great Britain and the Continent were connected by submarine cable, and in 1870 the telegraphs were purchased by the State.

After the toast of "The Prince and Princess of Wales," the Marquis of RIPON proposed "The Military and Civil Services of the Crown." Major-General WEBBER and Sir F. MOWATT responded.

Mr. SHAW LEFEVRE, M.P., proposed "The Telegraph Department." He contrasted the limited facilities for telegraphing that existed 25 years ago with those we now enjoy, and said that the success of the measure of Mr. Ward Hunt for the purchase of the telegraphs was largely due to the energy and ability of Mr. Scudamore. The Government bled freely to the telegraphic companies, but, even at double the real or market value of the telegraphs, the companies were a good riddance. The expenditure of capital and the supposed necessity of paying interest on it weighted the Department and prevented for years the reduction of charges. It was not till 1892 that Mr. Fawcett obtained the consent of the Treasury to the reduction of the charge for a message to 6d., and it fell to his lot, as Mr. Fawcett's successor, to devise a scheme for reducing the minimum charge. In this he was advised by Mr. Patey, one of the most able men in the public service. As to the financial results, a recent return showed that the telegraphs pay their annual cost, but no interest on the capital sum. But the division of expenses between the Post Office branch and the telegraphs branch was of a most artificial character. He had always contended that the two services should be looked at together financially. The net surplus revenue for the two services had been reduced during the last two or three years, owing mainly to great increases of wages, but it was still quite as high as it was in 1884—namely, 2¾ millions—which was a very large contribution to the national resources, the more so when we considered that no other country in the world derived a revenue from its postal and telegraph services. He was confident that in respect of celerity, of accuracy, and of wide extension, there was no telegraph service in the world superior to our own. Under the present able head of the telegraph department (Mr. Lamb), and under its engineer (Mr. Preece), there was security that any advance which an enlightened administration and science could suggest would be adopted, so as to maintain the service at its present high level.

Mr. J. C. LAMB responded, and dwelt upon the benefits which the telegraphs rendered to the country as far exceeding anything which could be presented in financial accounts.

LOANS FOR ELECTRIC LIGHTING.

The Finance Committee of the London County Council reported to that body on Tuesday in regard to certain loans to local authorities for electric lighting purposes. The reports were substantially as follow :

ST. PANCRAS.

We have again had under consideration the application of the Vestry of St. Pancras for a loan of £14,600 for the purposes of electric lighting. We reported on this subject on 17th July last, and recommended, consequent on the Council having granted 42 years to the Vestry of Hampstead for the repayment of a similar loan, that sanction should be given to the Vestry of St. Pancras borrowing £14,300, and that 42 years should be allowed for repayment. On the Treasury being notified that the Council proposed to advance the money to the Vestry, and to spread the repayment over 42 years, exception was taken to that period as being disproportionate to the life of the works. Consequent on such objection, communications took place with the Treasury, and eventually an agreement was come to with the Treasury that the periods for repayment of all loans for the initial cost of electric lighting undertakings should be limited as follows: for land, buildings, culverts, bare copper mains, and royalty licenses relating to such purposes 50 years, and for all other purposes 20 years. This agreement and the letters on the subject were fully set out in our report to the Council on November 20, 1894, when the Council confirmed the agreement as applicable to all future loans for electric lighting, and we have assumed that the Council does not wish to again reopen the question.

Applying these terms to the loans for electric lighting purposes made to St. Pancras Vestry, it is necessary to restrict the period for repayment of this loan (14,300) to 20 years, as the previous loans have been for longer periods. The Vestry of St. Pancras having been so informed, now ask that if the Council will not lend the money for 42 years, it will sanction the Vestry borrowing it elsewhere for that period. The Vestry do not seem to have realised that the agreement referred to above applies not only to loans to be advanced by the Council, but to all loans which the Council sanctions in pursuance of its statutory duty, and that the Council has taken great trouble to obtain the best possible terms for the local authorities in regard to loans for electric lighting

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purposes. Having carefully considered all the representations made to us by the Vestry of St. Pancras on the subject, we are unable to see our way to suggest any other course than that the Council should adhere to the principle embodied in the agreement with the Treasury, and sanction the borrowing by the Vestry of the sum of £14,300 at 3¼ per cent. for a term not exceeding 20 years. We recommend—

(*a*) That the seal of the Council be affixed to an order sanctioning the borrowing by the Vestry of St. Pancras of the sum of £14,300 towards defraying the cost of electric lighting works at a rate of interest not exceeding £3. 5s. per cent. per annum, such sum being repaid by such equal half-yearly or annual payments as will repay the amount borrowed within a period of 20 years from the date of the loan, and the interest also within the same period. (*b*) That the Vestry of St Pancras be informed that the Council will be prepared, should they desire it, to advance the sum of £14,300 on loan at 3¼ per cent. repayable in 20 years.

A suggestion was made that the period should be 42 years, and after discussion the report was referred back for further consideration.

ISLINGTON.

We have considered an application from the Vestry of Islington for a loan of £51,000 for electric lighting purposes. Of this amount the sum of £18,000 is to be applied towards defraying the cost of erecting a central station at the rear of Eden-grove, Holloway, for which contracts have been entered into for £23,792. 12s. 7d., and the sum of £33,000 is to provide the necessary boilers, engines, dynamos, fittings, switchboards, mains, pipes, and lamps, estimated by the Vestry to cost £34,269, and by the Council's engineer £32,844. The Council has already granted a loan of £9,000 for 55 years to purchase the site. Consequent on the agreement with the Treasury (as to the periods over which loans for the initial cost of electric light installations should be spread), as confirmed by the Council's resolution of November 20, 1894, the Vestry was informed that under that resolution we were prepared to recommend the Council to sanction a loan of £18,000 for 50 years, and £33,000 for 20 years. The Vestry has taken exception to our decision, and contend that the same treatment should be meted out to them as to St Pancras and Hampstead, by granting them 42 years for repayment, and that if the Council itself is not prepared to lend the money for that period, the Council should sanction unconditionally the Vestry borrowing the amount, leaving them to make the best terms they can with some financial corporation as to the rate of interest and the period for repayment, subject only to the restrictions imposed by the Metropolis Management Act of 1855, which provides (Section 190) for the repayment of any moneys borrowed by a sinking fund of not less than 2 per cent. of the amount borrowed, the Vestry regarding this as equivalent to repayment within 50 years.

It is hardly necessary to point out again that the consents in the St. Pancras and Hampstead cases were given before the agreement arrived at with the Treasury, and before the Council's resolution of November 20 last, according to which all loans for electric lighting purposes will for the future be sanctioned. The Vestry of Islington, like St. Pancras, does not seem to appreciate the Council's position in reference to giving its consent to the borrowing of money or to realise the impropriety of the Council consenting to the Vestry borrowing elsewhere for a period of years for which the Council cannot itself properly lend, and thereby rendering nugatory the agreement with the Treasury, a position which we submit it is quite impossible for the Council to adopt. We think that the same course should be adopted in this case as recommended in the case of St. Pancras, and we accordingly recommend—

(*a*) That the seal of the Council be affixed to the order presented herewith whereby the Council sanctions the borrowing by the Vestry of Islington of the sum of £51,000 towards defraying the cost of erecting a station and other works in connection with an electric light installation in the parish, at a rate of interest not exceeding £3. 5s. per cent. per annum, such sum being repaid by such equal half-yearly or annual payments as will repay the amount borrowed, as to £18,000 for the erection of the station within a period of 50 years, and as to £33,000 for plant and works within 20 years from the date of the loan, and the interest also within the same periods. (*b*) That the Vestry of Islington be informed that the Council will be prepared, should they desire it, to advance the sum of £51,000 on loan, at 3¼ per cent., repayable as to £18,000 in 50 years, and £33,000 in 20 years.

This report was also referred back for further consideration.

SHOREDITCH.

We have considered the application from the Vestry of Shoreditch for the loan of £12,200, on the annuity system for 55 years, to purchase a site for a dust destructor and electric lighting station. The Council on July 31 last sanctioned the borrowing of the money for the purposes stated, repayable in 55 years, and the Vestry now ask the Council to make the advance. Owing, however, to the delay in applying for the loan, it is now necessary to require repayment in 54 years. We recommend—

That, subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of Shoreditch for a loan of £12 200 to purchase a site for a dust destructor and electric lighting station be granted, on condition that the loan be taken up at once, interest being charged thereon at the rate of £3. 5s. per cent. per annum, calculated quarterly, and, with the principal, being repaid by such equal half-yearly payments of principal and interest combined as will repay the amount borrowed within a period of 54 years; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the consolidated loans fund.

The committee's recommendation was adopted.

LEGAL INTELLIGENCE.

LIVERPOOL OVERHEAD RAILWAY COMPANY v. THE MAYOR AND CORPORATION OF LIVERPOOL.

In the Queen's Bench Division on Tuesday, judgment was delivered by Mr. Justice Wills and Mr. Justice Wright in the case of the Liverpool Overhead Railway Company *v.* the Mayor and Corporation of Liverpool. The question raised by the appeal was whether the Liverpool Overhead Railway, which was leased by the Mersey Docks and Harbour Board to the company, was subject to be assessed to the sewering and paving rates of Liverpool. The appellants had been assessed, and had appealed to the Recorder, and from his decision the present appeal was brought. The appellants contended that the railway formed part of the Mersey Docks and Harbour estates, and as such was exempt from the rates by Act of Parliament. The respondents argued that the railway did not form part of the estate, and did not enjoy the immunity created by the statute.

Mr. Bingham, Q.C., and Mr. W. F. Taylor appeared for the appellants (the Liverpool Overhead Railway), and the respondents were represented by Mr. J. Walton, Q C., and Mr. T. F. Squarey.

Mr. Justice Wills said the foundation of the claim on the part of the overhead railway to be exempt from rating rested on the Liverpool Sanitary Act of 1846, Section 41, and the Liverpool Sanitary Amendment Act, 1854, which provided that the docks, etc., represented by the trustees of the Liverpool docks, should not be ratable in respect to any rates made under these Acts. Subsequently, the said estates, liabilities, and rights of the trustees were transferred to the Mersey Docks and Harbour Board, which was to enjoy all the rights which the trustees of the Liverpool docks then had or enjoyed, or would have had or enjoyed if the Act of 1857 were not passed. It had been assumed upon both sides that the effect of the legislation was that if the overhead railway had been made by the Mersey Docks and Harbour Board, and had been part of their estate, it would have been exempt from liability By an Act of 1888 the appellant company was incorporated, and it was under that Act of Parliament they claimed exemption. An agreement dated April 12, 1888, was entered into by which the appellant company agreed, as lessees, to execute the works authorised by the Acts of 1882 and 1887, and the argument was that a section of the Act of 1888 was applicable to the exemption of the appellant company. His lordship held that the section was intended only to confer upon the lessees whatever powers were to be found contained in the Act which related to the Board generally. Having reviewed the various Acts bearing upon the contention that the railway should be regarded as part of the estate of the Mersey Docks and Harbour Board, his lordship said he had come to the conclusion that the appeal should be dismissed with costs.

Mr. Justice Wright concurred.

COMPANIES' MEETINGS.

ANGLO-AMERICAN TELEGRAPH COMPANY.

The ordinary general half-yearly meeting of the Anglo-American Telegraph Company was held on Friday last at Winchester House, the Marquis of Tweeddale presiding.

The **Chairman**, in moving the adoption of the report and accounts, said that the traffic receipts during the past half-year showed a decrease of £6,948 as compared with the corresponding period of last year. This result was due, of course, to the extreme stagnation which had prevailed in commercial circles for so long a time. The condition of their cables was, on the whole, satisfactory, having regard to their age. The new cable was doing splendid work, and was quite able to carry the whole of their traffic. Their renewal fund amounted to £586,076, and the value of the securities in which it was invested, at the present market value, was £64,903. Since the beginning of the year there had been a substantial increase in their daily receipts, and if the increase continued during the half-year he had no doubt there would be a more favourable report. They proposed a dividend of 14s. per cent. on ordinary stock, making a total distribution for the last year of £2. 2s. per cent., and 28s. per cent. on the preferred stock, making a total distribution for last year of £4. 4s.

Mr. Bevan seconded the adoption of the report, which after some discussion was carried.

EASTERN TELEGRAPH COMPANY.

The half-yearly meeting was held last week at Winchester House, Sir John Pender presiding.

The **Chairman**, in moving the adoption of the report, said there was a decrease of £7,410 in gross revenue realised in the traffic with India, but otherwise there was very little difference between the receipts of the six months under review compared with the

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corresponding period of 1893. They had carried £4,860 to the maintenance of ships' reserve fund, or an increase of £1,768, as they had done comparatively little work for foreign Governments and for telegraphic companies in the half-year, so that a larger proportion of the depreciation of their ships had to be borne by themselves. There was a decrease of £27,077 in the amount carried forward, but then they had an exceptionally favourable half-year in that which ended September, 1893. However, he was pleased to say that they had recouped the decrease, so far that for the nine months to September 31 they showed a larger total than in the corresponding nine months of 1893, and if the traffic continued as favourable they would be able to show a fair result at the end of their financial year. They had not received the great dividends once expected; but this was owing to the cleverness of their customers, who so used the code that what would have been an enormous traffic was condensed in a few words. Governments showed full confidence in the Company, and he had just been in negotiations which had resulted in their Cape subsidy, which expired five years hence, being renewed for a subsequent 10 years.

The **Marquis of Tweeddale** seconded the adoption of the report, which was agreed to.

DIRECT UNITED STATES CABLE COMPANY.

The thirty-fifth ordinary general meeting was held at Winchester House on Friday last, Sir John Pender presiding.

The **Chairman**, in moving the adoption of the report and accounts for the half-year ended December 31 last, said that their half-year's revenue was some £2,710 less than in the corresponding period of 1893, while the expenses were about £1 300 less. Repairs to a short section of the cable had cost £1,612, debited to reserve fund account, which now amounted to £288,205. Their investment account had been increased by £9,441, and considerable appreciation had taken place in the value of the securities held. There were three powerful combinations for carrying on the work of telegraphing across the Atlantic; in fact, there were more cables than sufficient for the work to be done. As for their own, they were doing all in their power to keep it as thoroughly effective as possible, and at the same time increasing their reserve fund, believing they would be in a better position, with a strong reserve fund, when their cable did give out, than if they had to go to the public for money for a new one.

Mr. C. E. Gunther seconded the motion, which was adopted.

COMPANIES' REPORTS.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY, LIMITED.

Directors: Grosvenor Talbot, Southfield, Burley, Leeds (chairman); George Henry Crowther, civil engineer, Huddersfield; Robert William Eddison (John Fowler and Co. (Leeds), Limited), engineer, Leeds; Robert Hudson, engineer, Gildersome Foundry, near Leeds; Samuel Ingham (Illingworth, Ingham, and Co.), timber merchant, Leeds; Arthur Greenhow Lupton (William Lupton and Co), cloth manufacturer, Leeds; John Thomas Pearson, The Hall, Melmerby, S.O., Yorkshire. Consulting electrical engineer: Robert Hammond, M.I E.E, Ormond House, Great Trinity-lane, London, E C. Secretary: William T. Green.

Report of the directors to be presented to the ordinary general meeting of the Company to be held at the offices of the Company, Central Electric Lighting Station, Whitehall-road, Leeds, on Tuesday, February 5, 1895, at 2.30 p.m.

The directors submit herewith a statement of the income and expenditure for the past year, and the balance-sheet showing the assets and liabilities of the Company made up to December 31 last. The profit (including £155 6s. 1d. brought forward from the previous year) amounts to £3,671. 12s. 3d., which the directors propose to appropriate as follows:

In writing off the balance of preliminary expenses ...	£1,185	12	2
To set aside as a reserve fund	500	0	0
In payment of a dividend at the rate of 4 per cent. per annum upon the ordinary shares of the Company	1,823	18	4
Leaving to carry forward to next account	162	1	9
	£3,671	12	3

The directors trust that this result of the first full year's operations will be gratifying to the shareholders. The Company's plant (including that put down during the year) has continued to run satisfactorily, and the supply of current is maintained at a high standard of efficiency and regularity. On December 31 last the number of lights connected to the mains was equivalent to 19,858 35-watt lamps; whilst on December 31, 1893, the number was 10,647, showing a large increase for the year. An agreement has been made with the Corporation of the city of Leeds, under which the Company will shortly commence to supply all the electrical energy required in lighting the Leeds Town Hall and municipal buildings, where lamps equivalent to about 6,000 35-watt lamps are installed. The directors have given considerable attention to the question of encouraging the use of electricity for other purposes than lighting, with a view to securing a more constant employment of the Company's plant during daylight hours, and it has been decided to supply current for cooking, heating, and power purposes, at the price of 3d. per Board of Trade unit. As mentioned at the last general meeting, the directors were able to make a favourable agreement with Messrs. John Fowler and Co. (Leeds), Limited, for the exchange of the Company's 100-i.h.p. engine and 50-kilowatt dynamo for plant of four times the capacity, the business having developed so rapidly as to render such an exchange desirable. The new plant is expected to be completed during the coming summer, and the engines then at work will have an aggregate capacity of 1,800 i.h.p. As the extensions decided upon required a small amount more capital than that already provided, the directors arranged with the bankers for a temporary overdraft, secured by a mortgage debenture for £10,000, till the time arrives when a further issue of capital is considered desirable. The retiring directors, Mr. John Thomas Pearson and Mr. Robert William Eddison, being eligible, offer themselves for re-election. Mr. John Gordon, jun., offers himself for re-election as auditor.

Dr. CAPITAL ACCOUNT, DEC. 31, 1894.	£	s.	d.
Lands and buildings standing thereon at time of purchase, including law charges incidental to acquisition	10,151	5	8
Buildings (erected for the purposes of the Company)	11,362	2	10
Machinery	23,147	6	10
Mains, including cost of laying	10,289	2	11
Transformers, fuses, etc.	3,802	9	10
Meters	1,615	4	5
Electrical instruments, etc.	1,652	19	6
General stores (cable and mains)	834	17	7
Loose plant and tools	217	18	3
Office furniture and fittings	108	0	1
Cost of provisional order	936	19	10
	£64,118	7	9
Cr.	£	s.	d.
100 founders' shares of £5	500	0	0
10,000 ordinary shares of £5, £50,000; less calls in arrear, £23. 10s.	49,976	10	0
	50,476	10	0
Mortgage	6,000	0	0
Contributions to cost of mains	28	7	10
Total receipts	56,504	17	10
Balance of capital account	7,613	9	11
	£64,118	7	9

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1894.

Dr.	£	s.	d.
Coal, including carriage, unloading, storing, and all expenses of placing the same on the works	708	9	3
Oil, waste, water, and engine-room stores	214	6	4
Salaries and wages of engineers and workmen	1,442	16	11
Repairs and maintenance	266	2	9
Rates and taxes	130	14	1
Directors' remuneration	500	0	0
Salaries of secretary and clerks, stationery and printing, law expenses, and general establishment charges	461	0	11
Insurance	24	0	9
Total expenditure	3,747	11	0
Balance carried to net revenue account	3,709	17	2
	£7,457	8	2
Cr.	£	s.	d.
Sale of current, rental of meters and other apparatus, etc., after providing for discounts	7,245	15	3
Rents receivable	126	15	10
Transfer fees	3	2	6
Students' instruction	81	14	7
	£7,457	8	2

Dr. NET REVENUE ACCOUNT.	£	s.	d.
Interest on loan	240	0	0
Balance carried down	3,516	6	2
	£3,756	6	2
Balance of preliminary expenses written off	1,185	12	2
Reserve fund account	500	0	0
Dividend at the rate of 4 per cent. per annum upon ordinary shares	1,823	18	4
Balance carried to next account	162	1	9
	£3,671	12	3
Cr.	£	s.	d.
Balance brought from revenue account	3,709	17	2
Interest on deposit with Leeds Corporation	20	0	0
Bank interest	26	9	0
	£3,756	6	2
Balance brought down	3,516	6	2
Balance brought forward from last year	155	6	1
(Proposed to be appropriated as shown *per contra*.)			
	£3,671	12	3

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Dr. Capital and Liabilities.	£	s.	d.
Capital account: amount received	56,504	17	10
Sundry creditors	4,554	3	4
Amount due to bankers (Wm. Wms. Brown and Co.) (As security for this they hold a mortgage debenture for £10,000 upon the Company's undertaking, subject to a prior mortgage for £6,000 and interest.)	5,526	2	4
Net revenue account: balance brought forward from last year, £155. 6s. 1d.; profit for the year, £3,516. 6s. 2d.	3,671	12	3
	£70,256	15	9

Cr. Property and Assets.	£	s.	d.
Capital account: amount expended for works	64,118	7	9
Stores on hand at December 31, 1894, coal, £14. 5s. 6d.; oils, waste, etc., £43. 7s. 3d.; general, £143. 18s. 10d.	201	11	7
Sundry debtors for amounts paid on account of contracts in course of completion	452	7	6
Preliminary expenses (including all expenses of management during construction of works), £2,185. 12s. 2d.; less written off out of last year's profit, £1,000	1,185	12	2
Sundry debtors for current supplied to December 31, 1894, £3,347. 10s.; less reserved for discounts, etc, £140	3,207	10	0
Other debtors	34	5	0
Deposit with Leeds Corporation and interest	1,010	0	0
Cash in hand	47	1	9
	£70,256	15	9

LIVERPOOL OVERHEAD RAILWAY COMPANY.

Report of the directors and statement of accounts for the half-year ending December 31, 1894, to be submitted to the thirteenth half-yearly general meeting of the shareholders to be held at the Law Association Rooms, 14, Cook-street, Liverpool, on Tuesday, February 12, 1895, at 3 p.m.

Directors: Sir William Bower Forwood, J.P., Ramleh, Blundellsand; James Barrow, Esq., J.P., 7 Beach-lawn, Waterloo; John Brancker, Esq, J.P., Green Bank, Wavertree; Harold Brocklebank, Esq., 20, Bixteth-street, Liverpool; Richard Hobson, Esq., J.P., 54, Brown's-buildings, Liverpool; Edward Lawrence, Esq, J.P., 5, Fenwick-street, Liverpool; George H. Robertson, Esq., K 35, Exchange-buildings, Liverpool. Engineer and manager: S. B. Cottrell, Esq., A.M.I.C.E, 31, James-street, Liverpool. Secretary: William H. Alexander, Esq., C.A, 24, North John-street, Liverpool.

In presenting the half-yearly statement of capital and revenue accounts to December 31, 1894, the directors have to report that the gross revenue receipts amount to £25,700 19s. 2d., and the working expenses to £17,162. 4s 10d. The number of passengers carried since the opening of the railway being as follows:

	March 6 to June 30, 1893.	Half-year ending Dec. 31, 1893.	Half-year ending June 30, 1894.	Half-year ending Dec. 31, 1894.
First class	235,487	260 221	277 653	362,179
Second class	956,922	1,293,840	1,246 975	2,228,224
Workmen (special return tickets)	178,333	921,578	1,336 809	1,050,976
Total	1,370,742	2 475,639	2,861,437	3,641,379

The increase in the traffic shown by these figures is gratifying to your directors. The increased working expenses are mainly due to the additional train mileage of 70,933 miles due to the opening of the northern extension, and the cost of working the three new stations at the Nelson and Langton Docks and Seaforth Sands. The traffic on the northern extension has fully answered expectations, and the experience which the directors have thus obtained has determined them to ask the shareholders to approve of the construction of the southern extension, for which the Company hold parliamentary powers.

Revenue Account.

Receipts from passenger traffic amount to	£25,336	11	9
Miscellaneous receipts	364	7	5
	£25,700	19	2
Less working expenses	17,162	4	10
	£8,538	14	4
From which deduct—			
Interest on debentures and calls paid in advance	2,520	17	7
	£,6,017	16	9
Add balance brought forward, June 30, 1894	1,248	4	1
Leaving available for dividend	£7,266	0	10

Out of this balance your directors recommend the declaration of dividends at the following rates (less income tax), payable on and after the 16th day of February—viz., 5 per cent. per annum on preference shares. £2,428. 8s. 5d; 2 per cent. per annum on ordinary shares, £3,750—leaving a balance of £1,087. 12s. 5d to be carried forward to next half-year. The directors retiring by rotation at this meeting are Mr. E. Lawrence and Mr. G. H. Robertson, who, being eligible, offer themselves for re-election.

The auditor retiring by rotation is Mr. J. S. Harmood Banner, who is also eligible for re-election.

REVENUE ACCOUNT, HALF YEAR ENDED DEC. 31, 1894.

Half-year ended Dec. 31, 1893.	Expenditure.	£	s.	d.
£1.730 9 10	Maintenance of way, works, and stations (Abstract A)	2,624	1	1
4,089 17 2	Locomotive power (Abstract B)	4,253	2	1
	Repairs and renewals of carriages (Abstract C)	226	19	5
5,398 10 3	Traffic expenses (Abstract D)	6,672	0	10
1,375 10 7	General charges (Abstract E)	2,006	14	4
82 6 0	Law charges	78	0	6
1 12 6	Compensation	6	1	0
1,054 5 1	Rents, rates, and taxes	1,240	11	8
	Government duty	54	13	11
£13,732 11 5		£17,162	4	10
4,609 12 8	Balance carried to net revenue account	8,512	15	2
£18,342 4 1		£25,675	0	0

Half-year ended Dec. 31, 1893.	Receipts.	£	s.	d.
£18,000 11 7	Passenger traffic	25,336	11	9
2 5 4	Parcels, etc.	8	0	10
333 14 8	Rents	310	2	5
5 12 6	Transfer fees	20	5	0
£18,342 4 1		£25,675	0	0

Abstract A.—Maintenance of Way, Works, etc.

Half-year ended Dec. 31, 1893.		£	s.	d.
£15 0 0	Salaries, office expenses, and general superintendence	26	12	0
231 12 4	Maintenance and renewal of permanent way—wages, £402 7s. 8d;			
176 12 0	material. £76. 19s.	479	6	8
488 5 1	Repairs of structure and opening bridges	505	8	0
193 19 11	Repairs of stations and buildings	587	14	5
625 0 0	Provision for renewal of boilers, machinery at generating station, permanent way, etc	1,025	0	0
5·68	Miles maintained—double ... 6 4			
£1,730 9 10		£2,624	1	1

Abstract B.—Locomotive Power.

Half-year ended Dec. 31, 1893	Running expenses—	£	s.	d.
Costs under working agreement with the Electric Construction Company.	Wages connected with the working of generating engines and motors	2,396	5	7
	Coal and coke	939	9	8
	Oil, tallow, and other stores	206	15	8
		3,542	10	11
	Repairs and renewals—wages, £237. 6s. 3d; materials, £473. 4s. 11d.	710	11	2
£4,089 17 2		£4,253	2	1

Abstract C.—Repairs and Renewals of Carriages.

Half-year ended Dec. 31, 1893.	Carriages—	£	s.	d.
Covered by working agreement with the Electric Construction Company.	Wages	144	16	4
	Materials	82	3	1
		£226	19	5

Half-year ended Dec. 31, 1893.	Abstract D.—Traffic Expenses.	£	s.	d.
£4,038 12 6	Salaries and wages, etc.	4 957	13	5
1,017 13 6	Fuel, lighting, signalling, water, and general stores	1,284	8	3
67 19 3	Clothing	91	8	6
274 5 0	Printing, stationery, and tickets	338	10	8
£5,398 10 3		£6,672	0	10

Half-year ended Dec. 31, 1893.	Abstract E.—General Charges.	£	s.	d.
£350 0 0	Directors	350	0	0
52 10 0	Auditors	52	10	0
592 15 9	Salaries of secretary, general manager, and clerks	729	6	3
154 17 4	Office expenses of ditto	172	9	4
156 0 8	Advertising	62	18	3
69 6 10	Insurance	117	6	5
—	Travelling expenses	22	4	1
	Amount paid Liverpool Tramways and Omnibus Company	500	0	0
£1,375 10 7		£2,006	14	4

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Dr. GENERAL BALANCE SHEET, DEC. 31, 1894.	£	s.	d.
Capital account, balance at credit thereof	4,689	12	7
Net revenue account, balance at credit thereof	7,266	0	10
Interest payable or accruing, and provided for	2,437	10	5
Retention money	1,314	18	1
Sundry outstanding accounts	3,944	11	5
Renewal fund	2,275	0	0
	£21,927	13	4
Cr.	£	s.	d.
Cash in bank (current account) and in hand	16,443	4	9
Parliamentary deposit on extension railways authorised by Liverpool Overhead Railway Act, 1892, and interest thereon	4,121	0	9
Stock of stores and stationery	1,045	15	9
Sundry outstanding accounts	317	12	1
	£21,927	13	4

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq., Elibank, Taplow; Sampson Hanbury, Esq., Wyvenhoe Park, near Colchester; S. Barclay Heward, Esq, 96, Ashley-gardens, Westminster; Edwin Tate Esq., 21, Mincing-lane, London, E C.

Report of the directors, with abstract of accounts for the half-year ending December 31, 1894, to be submitted to the half-yearly ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E C, to-day at 3 p.m.

The receipts from all sources for the past half-year have amounted to £24,252. 13s. 4d., and the cost of working has been £14,762. 6s. 2d., leaving a profit of £9,490. 7s. 2d. Inclusive of the balance brought forward from June 30 last, the net revenue account shows an aggregate total of £10,919. 8s 10d. After making provision for the debenture and debenture stock interest, a balance remains available for dividend of £6,771. 12s. 10d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 1¼ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £950. 7s. 8d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Receipts (including season tickets).
December 31, 1890 (11 days)	165,000	£1,568 3 9
June 30, 1891	2,412,343	19,403 6 9
December 31, 1891	2,749,055	19,798 16 6
June 30, 1892	2,813,162	20,931 4 2
December 31, 1892	3,117,602	22,002 17 5
June 30, 1893	3,146,656	22,458 6 9
December 31, 1893	3,093 351	22,067 14 10
June 30, 1894	3 383 154	23 564 10 6
December 31, 1894	3,275,649	23,540 12 4
Total since the opening of the line	24,155,972	£175,335 13 0

During the past half-year there has been a very satisfactory and steady growth of the traffic during all hours of the day, but especially between 8 a.m. and 10 a.m. in the trains bringing passengers to the City. The trains between these hours have been considerably overcrowded, and as the small accommodation at the King William-street Station prevents any increase in the number of the trains run, a further advance in the fares during those hours has been made. This has had the effect of diminishing the overcrowding of the trains without seriously reducing the receipts. The substitution of motors on the train itself in the place of the present separate locomotives was found to be a more difficult operation than was at first expected, owing to the small size of the tunnels and the sharp curves near the entrance to the King William-street Station. After various experiments, these difficulties have at last been overcome, and a new motor-car train has been satisfactorily completed, and has been approved by the Board of Trade. As this alteration will give an increased carrying capacity to the trains, it is proposed to proceed with the conversion of the existing stock as rapidly as the exigencies of the traffic will allow. By means of these motor trains, there is every reason to expect that the increased traffic which may be anticipated during the present year will be able to be dealt with. But beyond that time there will be no means available for providing for any further increase that may arise, though from the steady growth of the traffic in the past such increase may be confidently expected. Your directors therefore feel that the time has arrived when some steps should be taken to carry into effect the powers granted by the Act of 1893 for the extension to Islington. They would recommend that the line should, in the first instance, be extended to Finsbury-pavement only, the estimated cost of which is £280,000. The first steps to be taken in connection with this operation will be the acquisition of the sites for the stations at the south side of London Bridge, the Bank, and Finsbury-pavement, and as these negotiations are likely to occupy a very considerable time, your directors recommend that they be authorised to proceed with the purchase of these sites at once, leaving the question of time for carrying out the works, and the most advantageous mode of raising the capital, to be discussed at a future meeting. This extension, when completed, would enable more than double the number of trains to be run, and a considerable increase in the accommodation of each train to be provided. The introduction of motor-car trains will necessitate further siding accommodation at Stockwell, which it is proposed to proceed with at an early date. Mr. J. P. Court has given notice of his intention to move at the half-yearly meeting the following resolution: "That the remuneration of the directors be reduced to £650 per annum until the Company pay a dividend at the rate of 2 per cent. per annum upon their ordinary stock." Your directors have always been willing to concur in anything that they believed would further the true interests of the Company; but, viewing the present resolution as practically one of want of confidence in the Board, they trust the shareholders will show by their presence at the meeting or by their proxies their confidence in the present directors. During the past six months £9,100 of the terminable mortgage debenture bonds have been paid off, leaving a balance of £78,000 of the bonds to be dealt with as they fall due. As the powers for the purchase of land under the Clapham Extension Act of 1890 expire this year, it has been necessary to promote a Bill in Parliament for an extension of the times specified in that Act and to sanction the raising of a small amount of additional capital to be expended on the new sidings at Stockwell and for other necessary works. There is also included in the Bill powers to enable the Company to hold its half-yearly meetings in January and July, when the accounts can be prepared and presented to the proprietors at a somewhat earlier date than at present. The Bill will be submitted for your consideration at the special meeting to be held at the conclusion of the half-yearly meeting. The director retiring by rotation is Mr. Charles Grey Mott, who is eligible for re-election.

The auditors retiring are Messrs. Turquand, Youngs, Bishop, and Clarke, who offer themselves for re-election.

Dr. REVENUE ACCOUNT.	£	s.	d.
Maintenance of way, works, and stations	526	10	10
Locomotive and generating power	5,792	2	4
Carriage repairs	357	3	10
Traffic expenses	5,713	6	2
General expenses	1,672	8	8
Law charges	25	4	8
Rates and taxes	670	1	2
Passenger duty	5	8	6
	14,762	6	2
Balance carried to net revenue account	9,490	7	2
	£24,252	13	4
Cr.	£	s.	d.
Passengers (3,275,649)	22,701	9	7
Season tickets (511)	839	2	9
	23,540	12	4
Parcels, etc.	48	12	8
	23,589	5	0
Transfer fees	19	7	6
Rent of property	550	2	0
Sundry receipts	93	18	10
	£24,252	13	4

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Balance from net revenue account	6,771	12	10
Unclaimed interest	164	6	11
Interest payable or accruing and provided for	1,380	2	7
Sundry outstanding accounts	4 178	18	7
Balance from capital account	3,853	5	3
	£16,348	6	2
Cr.	£	s.	d.
Cash at bankers, current accounts	4,062	3	3
Cash on deposit at interest	8 000	0	0
Cash in hand	687	1	10
	12,749	5	1
General stores	3,177	0	0
Sundry outstanding accounts	422	1	1
	£16 348	6	2

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Stourbridge.—The Upper Stour Valley Main Sewerage Board call for tenders for cast-iron pipes.

Lathom.—The Urban District Council of Lathom and Burscough require tenders for the supply of cast-iron pipes.

Madrid.—The General Directors of Posts and Telegraphs invite tenders by 19th inst. for 1,000,000 rolls of telegraph paper.

Newport (Mon.).—Tenders are invited for complete electric light installation for the Museum and Art Gallery, Dock-street, in accordance with plans and specifications, which may be seen upon application to Messrs. Swash and Bain, architects, Friars-chambers, Newport.

Hampstead, N.W.—The Vestry of St. John, Hampstead, invite tenders by the 14th inst for the supply of lubricating oil, tools, implements, and other electrical engineers' stores, carbons, and lamps. Further particulars may be obtained of the Surveyor, at the Vestry Hall, Hampstead.

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Weybridge.—The Urban District Council invite tenders for the public lighting of Weybridge on and after September 29. Tenders should state the number of public lights proposed, the illuminating power, and price per light. Tenders should be sent to Mr. Geo. Wheeler, clerk pro tem. to the Council, before 20th inst.

Manchester.—The Moss Side School Board invite tenders for the installation of the electric light in their schools in Princes-road, Moss Side. Plans, etc., may be obtained from Mr. S V. Clirehugh, A.M.I.C E., Temple-chambers, Brazennose-street, Manchester, on payment of £1. 1s , which will be returned on receipt of *bonâ fide* tender. Tenders are to be sent by Wednesday, February 6, to Mr. W. E. Rowcliffe, clerk to the Board, 30 Cross-street, Manchester.

RESULTS OF TENDERS.

Southampton.—The tender of Messrs. Crompton and Co., at £399. 18s., has been accepted for additional works of electric lighting at the Town Quay, for the Harbour Trustees. Mr. Aldridge was the consulting electrical engineer, and the estimate was £335.

BUSINESS NOTES.

Cardiff.—The new public library buildings are to be lighted by electricity.

Edinburgh.—A proposal is under consideration for the electric lighting of Waverley Market.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,412.

Cowes.—A committee of the District Council is considering the question of introducing the electric light.

Aberdeen.—Trinity Hall buildings are now lighted by electricity, Messrs. New and Mayne having carried out the contract.

Lancaster.—A committee has been appointed by the District Council to examine the plans of the Windermere Electricity Supply Company.

Submarine Cables Trust.—The sum of £1. 5s., balance of the coupon due October 15 last, will be paid by Messrs. Glyn, Mills, and Co. on and after February 1.

Wolverhampton.—A test of the electrical machinery was made last Friday, when the current was turned on to the whole of the arc lamps in the streets. The result was satisfactory.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 27th ult. amounted to £943, as compared with £632 in the corresponding week of last year.

Cuba Submarine Telegraph Company.—The directors recommend a dividend on the ordinary shares at the rate of 8 per cent. per annum, tax free, for the half-year ended December 31.

New Seaham.—The New Seaham Parish Council has been authorised to spend £325 on the lighting of the parish, either by gas or electricity. The Seaham Harbour Gas Company has quoted £3. 5s. per lamp per annum.

Liverpool Overhead Railway Company.—The directors recommend a dividend at the rate of 5 per cent. per annum on the preference, and of 2 per cent. per annum on the ordinary shares, less income tax, carrying forward £1,087.

Medical Electrical Institute.—Mr. Justice Kekewich, on the application on Wednesday, *ex parte*, of Mr. Henderson, for Mr. Furber, a debenture-holder, granted a receiver and manager over Friday next of the Medical Electrical Institute.

Tunbridge Wells.—The erection of the station is proceeding, and the buildings will probably be completed in a few weeks. On Monday the members of the Lighting Committee inspected the main thoroughfares for the purpose of determining the position of the arc lamps.

Llanelly.—It is stated that the Llanelly Gaslight Company have reduced the price of gas from 4s. 2d. to 3s. 10½d. per 1,000ft. Whether the proposal of the Borough Council to light the public buildings and main streets by electricity will come into effect is not yet known.

Moss Side.—Before the Urban District Council Mr. Johnston has complained of the defective lighting in the district, and has moved that it be an instruction to the Lighting Committee to prepare a scheme for the more efficient lighting of the district. The resolution was carried.

Electrical Oil Refining Company, Limited.—This Company has been registered, with a capital of £5,000 in £1 shares, to adopt an agreement and to acquire and develop certain patents relating to the bleaching, refining, sweetening, and purifying of oils and fats by means of electricity.

United Service Institution.—An electric light installation has been provided in this institution. It has been carried out by the General Electric Power and Traction Company, Limited, and Messrs Samuel Cutler and Sons, under the direction of Mr. E. Wingfield Bowles, electrical engineer.

Maidstone.—The Urban District Council having come to no satisfactory arrangement for the transfer of their provisional order, are still open to receive information as to the terms on which a company or firm would undertake and carry out the powers granted by the Maidstone electric lighting order.

Liverpool.—The Mersey Docks and Harbour Board propose to arrange four electric lamps at the entrance to the Alfred Dock, Birkenhead, at an estimated cost of £900. Negotiations are still proceeding with a view to the acquisition by the Corporation of the undertaking of the Liverpool Supply Company.

St. James's and Pall Mall Company.—The directors of the St. James's and Pall Mall Electric Light Company, Limited, recommend a dividend at the rate of 9 per cent. per annum on the ordinary shares for the half-year ending December 31, making with the interim dividend 6½ per cent. for the year.

William Warne and Co., Limited.—This Company has been registered with a capital of £300,000 in £10 shares. The object is to acquire the business of indiarubber manufacturers now carried on by Messrs. G. Coles, G. F. S. Warne, E. H. Coles, O. E. Coles, and J. Burbridge, at 29, Gresham-street, London, and Tottenham.

City and South London Railway.—The receipts of the Company for the week ended January 27 were £998, against £951 for the corresponding week of 1894, or an increase of £47. The total receipts for the current period of the present half-year are £3,999, against £3,839 in the corresponding period of 1894, an increase of £160.

Aberdeen.—Two additional applicants are announced for the post of electrical engineer to the Corporation of Aberdeen, the gentlemen being Mr. Walter H. Tittensor, assistant city electrical engineer, Dundee; and Mr. Wilfred C. Thomson, second resident engineer at the central station of the Westminster Electrical Supply Corporation.

Heanor.—An installation of the electric light has just been inaugurated in the dyeworks of Messrs. I. and R. Morley. The dye-house is 66ft. by 63ft., and in the centre are two 2,000-c.p. arc lights. The electric light has also been fitted up in the offices. The works have been carried out at a cost of £2,000. It is contemplated to instal nine other arc lamps on the premises.

Leeds.—The number of units sold by the Yorkshire House-to-House Electricity Company, Limited, during 1894 was 291,113. Mr. W. T. Green (the secretary) informs us that the respective numbers of 35-watt lights installed at different dates during the year were as follows: January 1, 10,647; March 22, 11,058; June 14, 11,548; September 6, 14,205; and December 31, 19,858.

Hartlepool.—A meeting of the Town Council was held last week to consider the question of the electric trams. Alderman Horsley moved that the notice of the intended application for a provisional order to amend the Hartlepool Tramway Order of 1883, 1884, and 1888, and the draft provisional order relating thereto, having been considered, the Council should approve of the application This was seconded by Councillor Hunter, and carried.

Charing Cross and Strand Company.—The Board of the Charing Cross and Strand Electricity Supply Corporation, Limited, have decided to recommend a dividend at the rate of 5 per cent. for the half-year ending December 31, making, with the interim distribution at the rate of 4 per cent. in August, a distribution for the whole year of 4½ per cent. The balance, of upwards of £2,300, is to be applied to reserve, depreciation, etc.

Tramways Electrical Traction Company, Limited.—This Company has been registered with a capital of £172,500, divided into 15,000 shares of £10 each, and 15,000 shares of £1. 10s. each. The object is to enter into and carry into effect an agreement with the Tramways Company of France, Limited, to acquire concessions, patents, or contracts relating to tramways, omnibuses, or light railways, and to carry on the business of carriers of goods and passengers.

Leominster.—Messrs. Bellow and Son, ironmongers and agricultural implement makers, have recently had their premises electrically lighted. The system of lighting the premises in the occupation of the firm was the work of Messrs. G. Reakes, electrical engineers and contractors, of Shrewsbury. The dynamo is of Messrs. Crompton and Co.'s make and is driven by a 6-h.p. gas-engine. The fittings were supplied by the General Electric Company, of London.

Ramsbottom.—During the past four months operations have been in progress at the works of the Ramsbottom Paper Mill Company, with a view to the lighting of the whole of their buildings by electricity. The installation has now been completed. The contract was held by Messrs. F. H. Royce and Co , of Hulme, The dynamo is capable of supplying current for 400 lamps of 16-c.p. Mr. J. T. Hans, on behalf of Messrs. Royce, has superintended the work.

Robert Sykes and Sons, Limited.—This Company has been registered with a capital of £20,000 in £50 shares. The object is to acquire the business of an ironmonger and iron and steel merchant carried on by Mr. R. Sykes at Stalybridge, Oldham, and Ashton-under Lyne, and to carry on the business of wholesale and retail ironmongers, iron and steel merchants, locksmiths, bell-hangers, gas and hot-water fitters, hydraulic, electrical, and mechanical engineers, etc.

Appointments Vacant.—Messrs. Allen and Co., of Queen's Engineering Works, Bedford, require a foreman in the electrical department to supervise 30 men and boys, winding armatures, magnet coils, etc. Applicants must have a thorough practical knowledge of drum bar and ring armatures, and the fitting and erection of dynamos.—The Yorkshire House-to-House Electricity Company, Limited, Leeds, have an opening for an improver with some electrical training.—The Telegraph Manufacturing Company, of Helsby, near Warrington, require an assistant electrician for the cable department.

Rhondda.—The committee, consisting of a member each of the five wards of the Rhondda Urban District Council, specially appointed to formulate a scheme to light the whole of the valleys by electricity, held its first meeting recently at the Public Offices, Pentre, to consider the replies received from the various colliery

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companies in the district respecting the matter. The proceedings were private, but the communications from the collieries are said to be favourable to the proposed scheme. The Rhondda District Council is now determined to light certain large sections of the valleys if not the whole, by electricity.

Hackney, N.E.—The question of the electric lighting of the parish came up for discussion at the last meeting of the Vestry. It was stated that the provisional order which was obtained some time ago would expire next June; that unless the Vestry took immediate steps the powers would most likely be taken out of their hands; that a local company would then step in and would undertake a supply. After several members had deprecated the latter course, it was decided to take up the question, and as some of the old committee had failed to get re-elected, or had resigned office, a new committee was appointed to make enquiries and forward this matter.

Prospect Steam-Pump.—Messrs. Cole, Marchent, and Co, of Bradford, have sent us a copy of their catalogue of a new and improved duplex steam-pump which they are putting on the market. The firm believe that this pump is the only direct-acting pump in the market which can be made to work and use steam expansively, consequently there is a saving of steam by its use. The expansion is capable of variation. In addition to this advantage, the firm claim to be able to pump a greater quantity of water than any other pump of the same size. If for electric light stations, the economy of steam obtained by this pump will be of advantage without in any way adding to the complication of the installation.

Ventilating Appliances.—An action was brought last week in the City of London Court by Messrs. Joel and Co. against Messrs. Matthews and Yates. It was brought by the plaintiffs, electrical engineers, to recover the sum of £25. 18s. 6d. against the defendants, of Swinton, near Manchester. Mr. Gray was counsel for the plaintiffs, and Mr. Arnold White for the defendants. The claim was for putting up certain ventilating apparatus at The Mecca, Cheapside, and the Champion Hotel, Aldersgate-street. The defence was that the plaintiffs had been paid all that was due to them, and that they were not entitled to recover any portion of the amount claimed. The defendants also contended that if the motors which were fixed were not satisfactory, they were to be removed, but that was denied. The jury found for the plaintiffs for £17. 15s. 7d.

Claim for Injuries—The record has been closed in an action in Aberdeen Sheriff Court at the instance of Mrs. Georgina Hogg against the Town Council, claiming £100 for damages. The plaintiff states that on July 10, 1893, the defendants were engaged laying along Castle-street electric wires for the purpose of giving a public supply of electric light in Aberdeen. On that date she had occasion to go to the New Market, and in passing along Castle-street fell into a part of the excavations, where she lay stunned until she was lifted out by some people who chanced to be passing. She avers that she was seriously bruised and injured, particularly on the left side and the left side of the head, and confined to bed for a fortnight. The Town Council admit that on that date their contractors, Messrs. Scott and Sellar, were engaged in laying electric wires in Castle-street, but deny that operations were being carried on at the part where the plaintiff says the accident took place.

Bath.—The clerk mentioned, in reply to a question at a meeting of the Surveying Committee of the Town Council last week, that he had forwarded the communication of the authority to the Board of Trade with reference to the electric lighting and the opposition of the authority to the application of the company. He also stated that he had received acknowledgements from the Board of Trade and also from the agents. At the same meeting Alderman Sturges mentioned that the quarterly bill of the electric light company had given him considerable trouble owing to the failures of the light. They were all very much obliged to the company for keeping their lights in when the gaslight was out, and therefore they ought to have some respect paid to them. At a previous meeting Mr. Knight moved a resolution with which he quite sympathised, that they should not be fined for any failure occasioned by the flood. There were several items in dispute, and he moved that they pay the company £521, the bill being £553, and leave the Lighting Committee to deal with the difference.

Carnforth.—The Lancaster District Council last week had before them the renewed application of the Windermere Electric Lighting Company for the consent of the Council to lay mains for the supply of current within their district. At a previous meeting consent had been refused on the ground that the company proposed to supply only part of the district, which would leave half of Carnforth without the electric current, and also because some members looked upon the power the company would have as a monopoly. Mr. W. Dodd, J.P., Silverdale, said he did not think any other company would be able to supply current with such advantage to the community. He understood their terms would be 3d. per unit, equal to 1s. 6d. per 1,000ft. of gas. Mr. E. B. Dawson, J.P., Aldcliffe Hall, said his only objection was that they proposed to supply only part of their district. It was quite certain that if they could utilise the water power of Lake Windermere with success, no other company would be able to compete with them. The clerk was instructed to ascertain on what terms the company proposed to supply the district, and Messrs. Dodd, Dawson, and Knowles were appointed to examine the plans and report at the next meeting.

Belfast.—The municipal central station, to which we referred in our last issue, was set in operation on Wednesday of last week. The ceremony of turning on the electric light was performed by the Lord Mayor (Mr. Wm. M'Cammond, J.P.) and Alderman W. J. Pirrie, J.P., chairman of the Electric Lighting Committee of the Corporation, in the presence of several of that committee and other members of the Corporation. Sir Samuel Black, town clerk, was also present, as were Prof. Kennedy and Mr. M'Cowen, electrical engineer to the Corporation. That evening 2,000 lamps were supplied to about 40 subscribers in the principal thoroughfares of the city. Immediately after the light was switched on, the Lord Mayor, Alderman Pirrie, and the other members of the Electric Lighting Committee and Corporation proceeded to the Theatre Royal for the purpose of satisfying themselves as to the character of the light supplied. The installation there has been carried out by Messrs. Richard Patterson and Co., of High-street. Besides Messrs. Patterson, the contractors who have carried out the wiring of other establishments were Mr. C. C. M'Carthy, William-street South; Mr. George Combe, High-street; Messrs. W. H. Drennan and Co, Fountain-street; Messrs. William Coates and Sons, Fountain-street; Messrs. T. Verity and Sons, Messrs. Cooney and Swan, Mr J. H. Greenhill, Messrs. Gent and Co., Mr. J. Hind, jun., Victoria-chambers, and Messrs. Allen and Sons.

Great Northern and City Railway.—The Great Northern and City Railway Company, incorporated by Act of Parliament with a share capital of £1,500,000 in £10 shares, announces the issue of £1,000,000, the application list for which will close on or before Monday. The line will be about three miles long, and will be connected with and afford direct through communication between Finsbury Park, where the various suburban lines of the Great Northern Railway Company converge, and Moorgate-street, in the City of London, and will provide a frequent service for the densely-populated districts through which it passes. The motive power will be electricity, but the railway will differ from other electric railways in that the tunnels will be of main-line size, and will take the Great Northern's heaviest suburban trains. The estimated cost of the whole undertaking is £1,400,000, the contractor constructing and equipping the line for a fixed maximum sum. The Great Northern Company, besides constructing at its own cost so much of the railway as lies north of Drayton Park, also guarantees, in connection with through traffic only, minimum payments and rentals, together amounting to about £30,000 per annum, for one-fourth of the train service and other accommodation. This sum is equivalent to £2 per cent. per annum upon the whole share capital. The annual income from local traffic is estimated at £90,000, and the working expenses, exclusive of the Great Northern contribution, at £50,000.

Fareham.—A resolution was passed last week at a meeting of the Fareham Urban District Council asking the Local Government Board to withhold consent to the borrowing of £7 000 for the purchase of the undertaking of the Fareham Electric Lighting Company, Limited, on the ground that the ratepayers were opposed to the said purchase as evidenced by the recent election. After Mr. Sandy had given notice of his intention to move the resolution in question, a letter was received from the Local Government Board stating that the effect of communications addressed to that body, and the consideration of evidence taken at the recent enquiry conducted by Colonel Marsh, led to the conclusion that it was doubtful whether the proposed purchase met with the approval of the general body of ratepayers of the district, and having regard to the fact that the Fareham Urban Council had come into office since the application for sanction to the loan was submitted, the Board had decided to defer dealing with that application until informed whether the Council desired to proceed with the matter. It was agreed that the letter should be brought forward for consideration at the February meeting of the Council, and Mr. Smith gave notice of a motion that in the interests of the ratepayers it was desirable that the Council should make the following offer to the electric lighting company—viz, to pay to the company an additional sum of £150 per annum for lighting the town until the termination of the company's existing contract in September, 1896, subject to the terms and conditions set forth in the managing director's circular of June 1, such payment to commence from March 1 next, and in other respects the terms and conditions of the existing contract to remain in force conditionally upon the withdrawal by the company of the *quasi*-contract for the sale and purchase, and that the clerk be instructed to make the offer at once.

Ealing.—The Electric Lighting Committee reported to the Urban District Council last week that an application had been received from Mr. Landor, photographer, asking when the electric light would be available all day. The surveyor informed the Council that a day supply of the current was not practicable at present; there was not sufficient demand to warrant the provision of such a supply. The committee further reported that 64 applications, involving 4,033 lamps, had been received for private installations of the electric light; 54 of these requested installations, with a total of 3,375 lamps, had been made. Sixty-three of the street arc lamps had been erected, and the electric lighting of the Uxbridge-road had been finished from the Acton boundary to the Culmington-road at Ealing Dean; the centre road lamps from the latter point to the Hanwell boundary, the erection of which would complete the street-lighting of the district, would it was expected shortly be put up. The extension of the mains to The Avenue at Castle-hill, for private lighting purposes, was being proceeded with. The committee further reported that they were of opinion that the time had arrived when Messrs. Bramwell and Harris, the engineers employed under the electric lighting scheme, should make some definite report concerning the whole of the electric light installation and the completion of the work. The committee recommended that Messrs Bramwell and Harris should be asked to make this

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report accordingly. The recommendation was adopted by the Council, as was also a recommendation by the Finance Committee that Messrs. Bramwell and Harris should be requested to furnish a statement of accounts with reference to the electric lighting showing the amount of work already done and the further sum estimated to be required, and also distinguishing the extra works in respect of which special instructions had been given by the Local Board.

Signal Recorder for Ships.—Messrs. J. Davis and Son, of Derby and London, are introducing the Thompson and Marsden recorder, which is a simple one, and records indelibly every order signalled to the engine-room from the bridge, and also the exact hour and minute at which every order was signalled. Under the present system no record exists of the orders that are given, and in a large majority of cases of collision or accident the only evidence before the court is the statement of the master on the one hand, and the engineer on the other, which evidence is frequently very conflicting both as to the orders given and also as to the time elapsing between orders. It is obvious that these are matters of the utmost importance in arriving at a decision as to whom is to blame. The instrument now invented in no way interferes with the action of the indicators already in use, but is merely an accessory and a silent and accurate witness and recorder of every movement of the indicator. The recorder consists of a drum which revolves once in 12 hours, the motive power being supplied by a powerful English eight-day clock. Around the drum a chart is placed which is renewed at 8 a.m. for the day watch, and at 8 p.m. for the night watch. The chart contains a column of all the words of command printed within horizontal lines which run the whole length of the chart; vertical lines divide and subdivide the chart into hours, quarters, and single minutes, and as the space allotted to each minute measures one-eighth of an inch, the eye can easily subdivide this into smaller fractions of time. A metallic pencil rests upon the chart, and by simple mechanism is connected with the existing indicators in such a manner that the recording pencil is moved up and down by the action of the indicator, thus producing vertical lines on the chart, and the completion of the diagram is brought about by the revolution of the drum. The effect of the recorder is threefold: (1) long vertical lines show the precise moment at which the signal-bell rang; (2) angles show the time at which each order was given and what that order was; (3) horizontal lines show how long each order remained in force without alteration. There is no question as to whether the recorder will do the work the inventors claim for it, as it has already been subjected to a long and severe test by a well-known steamship company with complete success. Several high authorities on nautical matters have expressed their opinion that the want of such an instrument has been long felt, and no doubt before long a recorder will be considered a necessary equipment of all steam vessels.

Lambeth, S.E.—An animated discussion took place at a meeting of the Vestry last week on the question of electric lighting in the parish. The question arose upon the report of the clerk (Mr. H. J. Smith) as to the position of the parish in regard to the electric lighting order. He explained that in 1892 powers were given to the Vestry to light the whole of the parish except the two areas comprised in the orders granted to the London Electric Supply Corporation and the Installation and Maintenance Company. The order granted to the Vestry provided that they should, within a period of two years after June 27, 1892, lay down and maintain sufficient distributing mains for the purposes of general supply of electricity throughout all the streets in which tramway lines are laid down (except Milkwood-road), with the addition of Effra-road, Tulse-hill, Denmark-hill, Herne-hill, and Knight's Hill-road. The order further required the Vestry to lay down at any time after the expiration of 18 months from June 27, 1892, sufficient distributing mains for general supply throughout every other street within the area covered by the order within six months after being required to do so in the manner provided by the order. The Vestry had not up to this time taken any steps under the order or done anything to carry out its provisions, and the order was liable to be revoked at any time by the Board of Trade. Should any company apply this year for an order the Board of Trade would hardly pay much attention to any opposition of the Vestry if they, having an order, declined or neglected to put its powers into force. Mr. Hubbard moved that the report be referred to a special committee for consideration and report. Mr. Everett seconded. Mr. Hooper said he failed to see why the matter should be referred to a committee, seeing that it had already been fully considered. He believed there were a large number of members of the Vestry opposed to the expenditure of a large sum of money upon electric lighting. He moved, as an amendment, that the Board of Trade be asked to extend the time under the order. The amendment having been seconded, Mr. Hubbard, in replying to the discussion, complained that many speakers had done an injustice to Mr. Preece in not quoting the full context of his report. As to Mr. Howlett's speech, it was the most thorough monopolist utterance he had ever heard. But why did not Mr. Howlett and others who thought with him face the plain issue—whether they should abandon the order or not. Well, that was the logical conclusion of Mr. Howlett's attitude. He (Mr. Hubbard) did not ask them to enter upon a speculation, but simply to appoint a couple of dozen men, rather than 120, to give them information. Then they could have some concrete resolutions to accept or reject. Mr. Hooper eventually withdrew his amendment, and a proposition by Mr. Ogilvie to hold a special meeting in three weeks' time to consider the question was, on a division, adopted. Mr. Williams gave notice that at the special meeting he should move that the provisional order should be surrendered.

Leeds Tramways.—In the course of an article on the subject, the *Yorkshire Post* of Tuesday's date says the Tramways Committee has for many months past been enquiring into and obtaining information of the various systems of tramway traction in use in the country, with a view of guiding the Highways Committee to a conclusion as to the system that would be most likely to suit the requirements of Leeds; and for several weeks the information so gained has been in process of being boiled down into a concise and readable report. The document came for the first time before the committee a week ago. As the question is one of interest to every burgess of Leeds, it might have been thought that the committee, having at last produced its report, would at once take the Highways Committee, the Corporation, and the ratepayers into their confidence by publishing it. Instead of doing this, however, precautions were taken to keep the contents of the report secret. Again, at an adjourned meeting of the committee (Alderman Firth presiding), held on Monday, greater precautions were taken to keep secret what was no longer a secret—the committee sitting with guarded doors. The more important portions of the report have leaked out, the parts withheld being the grounds on which two special systems of traction found favour. It was stated on Saturday that the decision of the committee would lie between cable traction and electric traction, and as far as the report was concerned the consideration of those two methods occupied Monday's meeting entirely. Addressing themselves to the subject-matter of the report, and mainly to that portion of it which relates to the system of traction to be selected, the members of the committee spent about an hour in comparing the respective merits of the electric and the cable methods, which seem to the city engineer, Mr. Hewson, and the committee, to be the only two feasible systems. In the course of the debate the meeting was informed that the cost of working cars by means of electric overhead wires, including equipments, is about £10,000 a mile per annum, that if electric wires are laid underground the outlay will be about £14,000 a mile, that the cable system would involve an outlay of about £12,000 per mile a year, and that about 25 miles of tramway are now being worked by the Corporation. Eventually the committee declared itself in favour of electricity as the motive power of the future, and proceeded to consider the difference in the cost of overhead and underground wires. A strong desire was expressed to the effect that in all the main central thoroughfares the electric wires should be underground, if that arrangement would not militate against successful working. A majority of Alderman Firth's colleagues did not seem to mind the extra £4,000 a mile for electric wires in conduits provided the smooth and punctual running of the cars could be ensured. Ultimately the city engineer was asked to furnish the committee with all the information at his command as to the extra cost which would be incurred by the laying of the electric wires in conduits in the heart of the city. Mr. Hewson was also asked to afford the committee all the additional information he can as to the relative advantages and disadvantages, particularly with reference to cost, of the overhead and underground electric systems. The meeting was adjourned for a week to allow the engineer time to prepare the further details required. When the Leeds Tramways Committee first addressed itself about a year ago to the question of what system of haulage they should adopt, two or three proposals were brought before them; but later on, when they advertised for tenders for working the lines, the only tender received was from Mr. W. S. Graff Baker, who instituted the Roundhay electric tramways. Mr. Graff-Baker's tender was sent in on behalf of a company with which he is associated, and the terms were as follows: for a lease of the tramway lines in Leeds for a period of 21 years, with a right to use a conduit or underground electric service in the centre of the city and an overhead wire electric service outside such centre, he offered, subject to the conditions governing the tenders, the sum of £615 per mile of single line per annum by way of rental. Including the Roundhay and Harehills road and Beckett-street tramways, the total length of single line within the city is, in round numbers, about 28 miles; and for the use of this Mr. Graff-Baker offered £17,220 per annum. To the acceptance of this offer at the time it was received and discussed many of the members of the committee were favourable; but as they had begun their enquiries into the several systems of traction in use in this country and on the Continent, they resolved to proceed until they had exhausted the question. The offer still holds good, and the generally favourable impression produced by it originally has not been removed by subsequent enquiries.

PROVISIONAL PATENTS, 1895.

JANUARY 21.

1385. **Improvements in galvanic batteries.** Henry Tipping, 55, Chancery-lane, London.

1405. **Improvements in electric arc lamps.** Louis Barrière, 46, Lincoln's-inn-fields, London.

JANUARY 22.

1436. **Improvements in and relating to pillars or posts for electric lighting, carrying electric wires, railway signals, and the like.** John Bell Millar, of the firm of George Smith and Co., Sun Foundry, Limited, 96, Buchanan-street, Glasgow.

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1442. **Improvements in electrical ceiling roses.** Charles Leigh Clarke and William Paul Theermann, 7, South parade, Manchester.

1446. **Improvements in galvanic batteries.** Charles Bernhardt Schoenmehl and Clark Murray Platt, 70, Wellington-street, Glasgow. (Complete specification.)

1474. **Electromagnetic brakes.** John Hopkinson, 5, Victoria-street, Westminster.

1477. **Improvements in feeding mechanism for electric arc lamps.** Henry Bevis and Gustav Binswanger, 73, St. Stephen's-road, Upton Park, London.

1478. **An improved insulated support for electrical conductors.** Hugo Hirst, 73, St. Stephen's-road, Upton Park, London.

1504. **Improvements in coin-controlled apparatus for producing various electrical phenomena or effects.** William Phillips Thompson, 6, Lord-street, Liverpool. (Joseph L. Ketcher, United States.) (Complete specification.)

1512. **Improvements in electric arc lamps.** Sir Charles Henry Augustus Frederick Lockhart Ross, Bart., 6, Bream's-buildings, Chancery-lane, London.

1526. **Underground conduit for electric roads.** Ezra Aley Mather, 40, Chancery-lane, London. (Complete specification.)

1536. **Improvements in or in connection with alternating-current electric motors.** Brown, Boveri, and Co., 46, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883, Section 103, July 3, 1894, being date of application in Switzerland.)

1544. **Improvements in and relating to electrical conductors.** Edward Dudley Lewis, 77, Chancery-lane, London. (Complete specification.)

JANUARY 23.

1546. **An electric switch.** Frank Wright and Edward Jesse Piper, 34, Victoria-street, Westminster. (Complete specification.)

1550. **Improvements in electrical switches.** Charles Leigh Clarke and William Paul Theermann, 7, South-parade, Manchester.

1558. **Improvements in ceiling roses and other similar electric fittings.** John Glynn Williams and Henry Mostyn Darrah, 70, Market-street, Manchester.

1587. **Improvements in or appertaining to electrical clocks, bells, indicators, and similar instruments.** Frank Hope-Jones and George Bennett Bowell, 31, High Holborn, London.

1611. **Improvements in and connected with the electric lighting and heating and also the ventilation of railway carriages and other vehicles.** Edwin James Preston, of the firm of J. Stone and Co., and Arthur Bernard Gill, 77, Chancery-lane, London.

JANUARY 24.

1649. **Gas-engines, ignition by electricity.** Henry Crane, jun., 182, Moseley-street, Birmingham.

1676. **Improvements in electrical storage batteries.** Thomas Ballard Marchant and John Woolley, 42, Manby-grove, Stratford, London.

1697. **Improvements in and connected with arc lamps.** Hermann Niewerth and Regina Niewerth, 37, Cursitor-street, Chancery-lane, London.

1698. **Improvements in electric current regulators.** Hermann Niewerth and Regina Niewerth, 37, Cursitor street, Chancery-lane, London.

1707. **Electric water-gas.** John Henrique Dunn and John Parsons, 272, Holloway-road, London.

1710. **Safety fixing for the various decoration covers and lamp-holders for electric light fittings.** Francis James Curley, 49, Flood street, Chelsea, London.

1714. **An improvement in electrical glow lamps.** Siemens Bros. and Co, Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

1717. **Improvements in and relating to electric accumulators.** Oscar Pirsch, 45, Southampton-buildings, Chancery-lane, London.

1730. **Improvements in electrical devices for lighting cigars, or for other like purposes.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

1731. **Improvements in secondary batteries.** Camille Alphonse Faure and Frank King, 47, Lincoln's-inn-fields, London.

JANUARY 25.

1744. **Improvements in microphones or telephone transmitters** Clarence Metcalfe Stead and Lawrence Walter Douthwaite, trading as the Electrical Mechanical Agency Company, 2, East-parade, Leeds.

1788. **Improvements in apparatus for the manufacture electrolytically of tubes and other articles of circular section.** Francis Edward Elmore, 28, Southampton-buildings, Chancery-lane, London.

1797. **Improvements in filaments and carbons for electric lamps.** Peter Stiens, 24, Southampton-buildings, Chancery-lane, London.

JANUARY 26.

1824. **Improvements in wattmeters.** John Perry, 31, Brunswick square, London.

1835. **Improvements in electric exploders.** Herbert Vivian Keeson, 40, Loudoun-road, St. John's Wood, London.

1840. **An improved carbon transmitter or microphone.** Guillaume Arnaud Nussbaum, 29, Ludgate-hill, London.

1854. **Improvements in electric burglar alarms for doors.** Gerald Rickett Blackburn, 2, Market-street, Bradford.

1867. **Improvements in shade-holders for electric, gas, or other lights.** William Everett Gibson and Hugo Hirst, 73, St. Stephen's road, Upton Park, London.

1885. **Improvements in insulating devices or attachments for electric wires.** Augustus Henry Weikman, 6, Lord-street, Liverpool.

1899. **Improvements in connection with electric railways or tramways.** Edgar Mapple, 47, Lincoln's-inn-fields, London.

1906. **Improvements in electric condensers.** George Threlfall, 46, Lincoln's-inn-fields, London. (Richard Threlfall, Australia.)

SPECIFICATIONS PUBLISHED.

1888.

1383. **Electromotor, etc.** Borel and Paccaud. (Second edition.)

1893.

18428. **Electric telegraphs.** Draper and Fraser.

1894.

669. **Electric batteries.** Wollaston.
764. **Jointing and connecting electric cables.** Nisbett.
2118. **Electric lamps.** Fabris.
3217. **Electric arc lamps.** Joel.
4325. **Electro-deposition of aluminium.** Harris.
4554. **Telephony and telegraphy.** Adams-Randall.
4572. **Telephone transmitters.** Adams-Randall.
4610. **Electricity meters.** Moy.
8808. **Electric batteries.** R. McL. and A. McDonald.
17728. **Electrically-propelled vehicles, etc.** Sperry.
17845. **Electric arc lamps.** Devonshire. (Thomson.)
23012. **Electric signalling systems.** Walter.
23441. **Galvanic batteries.** J. C. and G. Fuller.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5⅝
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅝-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2⅝-2⅞
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	4½-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	15¼-15⅝
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	48-50
—— 4 per cent. Debenture Stock	100	128-130
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	3-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	102-107
Electric Construction, Limited	2	¼-½
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1½-1⅝
Elmore's French Company	2	1/16-3/16
Elmore's Wire Company	2	1-1¼
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	9-10
—— Preference	—	12
House-to-House Company, Ordinary	5	2½-2¾
—— 7 per cent. Preference	5	6½-7
India Rubber and Gutta Percha Works	10	24½-25½
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	—	7-7½
Liverpool Electric Supply, Ordinary	5	7 5/16-7 7/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8½-8⅝
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	½-¾
Metropolitan Electric Supply	10	9¾-10½
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	5½-5¾
—— 6 per cent. Cum. First Pref.	10	16-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	7-7½
Oriental and Electric Company, £1 shares	1	1⅛
—— £5 Shares	—	7-7½
—— £4½ shares	—	5¾-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅞-8½
—— 7 per cent. Pref.	5	8¾-9½
Swan United	—	—
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7½-8
Yorkshire House-to-House	4½	4¼-4½

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NOTES.

Society of Arts.—On Wednesday next, at 8 p.m., a paper on "Light Railways," by Mr. W. M. Acworth, will be read.

South Africa.—The Matabeleland telegraph is now open to Gwelo, which is regarded as a very promising mining centre.

Liquid Fuel.—Experiments are about to be made with liquid fuel on one of the river firefloats of the London County Council.

Electric Carriage.—An electric carriage, equipped with Fulmen secondary batteries, is now to be seen in operation in Paris.

Electric Railways.—The *Financial Times* of Saturday last devoted a long leading article to this subject, which it looks upon with favour.

Light Railways.—The Queen's Speech promises that a proposal will be presented to Parliament for facilitating the construction of light railways.

First Aid.—Mr. W. S. Hedley, M.D. (Edin.), again discusses in the *Lancet* the question of first aid in the case of accidents caused through electric shocks.

A Novelty.—The *Echo*, on Wednesday, discovered the existence of something in connection with electric light mains which it describes as "a heavy volt cover."

Unique Switches.—A revised price-list of the various types of "Unique" switches made by Mr. A. P. Lundberg, of Bradbury-street, Kingsland, N., London, has been issued.

Good for the Trade.—A dispute between two actresses engaged in a Sheffield pantomime resulted, a few days ago, in the smashing of the lamps in the electric ballet.

Sanction of Loan.—The Treasury have sanctioned the loan by the London County Council of £12,200 for the erection of a dust destructor and electric lighting station by the Shoreditch Vestry.

Institution of Civil Engineers.—On Tuesday next, at 8 p.m., a discussion will take place upon the paper, by Mr. John Richardson, on "The Mechanical and Electrical Regulation of Steam-engines."

A Good Library.—The German Minister of Finance has bought the library of the late Prof. von Helmholtz for the Physikalisch-Technische Reichsanstalt. The professor was the head of this institution for many years.

Electric Light in France.—In accordance with the resolution taken last November, tenders are now being invited for the electric lighting of the Chamber of Deputies. Only French firms will, however, be allowed to tender.

The Brooklyn Strike.—The United States militiamen, according to a sketch in the New York *Electrical Review* illustrating the strike of tramway employés in Brooklyn, very much resemble many of the French soldiers.

Institution of Electrical Engineers.—A paper on "Reversible Regenerative Armatures and Short Air-Space Dynamos," by Mr. W. B. Sayers, associate, will be read at a meeting of this Institution on Thursday next, the 14th inst.

Personal.—Mr. E. O. Walker, who was formerly connected with the Indian Government Telegraph Department, has been appointed to succeed Mr. Simpson as superintendent of telegraphs and electrician in the island of Ceylon.

London and Epping Forest Railway.—Mr. Campion, examiner on Standing Orders, decided on Tuesday that the Standing Orders had been complied with in the case of the London, Walthamstow, and Epping Forest Railway Bill.

Thomson-Houston Regulator Patent.—Judge Grosscup has dismissed the bill of the Thomson-Houston Electric Company against the Western Electric Company for alleged infringement of the Thomson-Houston dynamo regulator patent of 1881.

Correction.—The two feed pumps mentioned last week in our description of the Wolverhampton electricity works as being of the Cameron duplex type, should have been stated to have been of the single-ram vertical type, made by Mr. Jos. Evans, of Wolverhampton.

Northern Society of Electrical Engineers.—A paper by Mr. G. S. Corlett, member of council, on "Electricity as Applied to Mines," will be read before this society at a meeting to be held on Monday next at the Palatine Hotel, Hunt's Bank, Manchester.

The History.—An esteemed contemporary, which a few weeks ago did not like our giving historical sketches of the steps leading up to the adoption of the electric light by municipal authorities, has now followed our example. That is always the worst of setting a bad example.

Use of Electric Motors.—A pamphlet bearing the title of "The Application of Electromotors for Power Purposes" has been issued, at the price of 1s., by Mr. T. L. Miller, A.M.I.C.E., M.I.E.E., of 7, Tower-buildings, N. Water-street, Liverpool. The pamphlet deals with various cases where electric motors have been introduced, and points out their advantages.

Storage Battery Traction.—The *Zeitschrift für Elektrotechnik* of the 1st inst. contains nearly 20 pages relating to the employment of the Waddel-Entz accumulators for traction purposes in Vienna. It will be remembered that the experiments about to be commenced are to be watched by a technical commission, who will furnish a report on the subject.

Lecture.—A lecture, entitled "Electricity in Mining," was delivered on Wednesday of last week by Mr. G. R. Peers, A.I.E.E., before the mining class in connection with the Walkden Technical Instruction Committee. Some experiments were performed during the evening, including electric shot-firing, which system is coming into general use in the collieries of the district.

Chicago Edison Company.—Some 20 pages of the New York *Electrical Engineer* of the 23rd ult. are devoted to an illustrated description of the history and work of the Chicago Edison Company. It appears that no less than 40 per cent. of the total output of the company is utilised for driving motors, by no means confined to the fan or smaller sizes, but running up to 50 h.p. or 60 h.p., and in one case even to 110 h.p.

Long-Distance Telephony.—A Vienna correspondent telegraphs that the Austrian Government has accepted a proposal made by Italy for a telephone line to be constructed between Vienna and Milan. The line will be ready in the course of this year. Telephone communication between Milan and Rome is already existing, and the line connecting the Austrian and Italian capitals will be, it is stated, the longest in Europe.

Central Stations in France.—*L'Industrie Electrique*, of Paris, publishes, in its issue of January 25, its fifth edition of statistics of central stations in France, the figures being brought up to January 1, 1895. The number of stations in existence or in progress in France amounts to 440. These figures, however, include installations which supply only a couple of consumers. The

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figures for Algiers are 11; for Réunion, 1; and for Senegal, 1.

State Telephony.—Judging from a circular recently issued by the French Postal Administration, State telephony there is in a peculiar position. The amount voted for telephony when the Government took over the telephone system in 1889 has only been paid in half, and that has been expended, and the Department has now been compelled to decline to accept further subscribers to the system. This exemplifies, a French contemporary says, the beauties of the working of the telephone service by the State.

Refuse Destructors.—The *Surveyor* in its last issue prints as an editorial comment, but without acknowledgement, some of the remarks made by Mr. F. H. Medhurst to a *Pall Mall* young man on the subject of refuse destructors. Like the young man in question, as mentioned in our last issue, the *Surveyor* seems to be ignorant of the fact that Mr. Charles Jones, the surveyor to the Ealing District Council, was the first to carry into practice the use of refuse destructors for steam-raising purposes in connection with electric lighting from a central station.

Institution of Engineers and Shipbuilders.—The fifth general meeting of the present session will be held in the lecture hall of the Literary and Philosophical Society of Newcastle-upon-Tyne, on Tuesday next, at 7.30 p.m. The business will include the reply of Mr. F. Caws to the discussion on his paper on "Ship Acceleration and Fluid Resistance"; discussion on Mr. W. C. Mountain's paper on "The Design and Efficiency of Plant for the Transmission of Power by Electricity"; and a paper on "The Application of the Electric Arc to Machinery, Boiler Repairs, etc.," by Mr. Henry Foster, will be read.

Fire Alarm.—The Geneva Society of Arts have had brought under their attention by Mr. J. Bulet an alarm for giving warning of a rise in temperature in any room. The apparatus, as lucidedly described by a French contemporary, is formed of a metal stem, the dilation of which causes a contact to be made and an electric bell to ring. This alarm is regulated for the normal temperature of the room, and any increase in the temperature due to an abnormal condition is immediately made known. The sensitiveness of the alarm is such, our contemporary concludes, that a match or a piece of paper held underneath it will cause the bell to ring. The sensitiveness of the alarm seems to be such that most people would prefer to dispense with it, on the ground of over-sensitiveness.

Compressed Air v. Electric Traction.—A note in our business columns last week referred to the registration of the Tramways Electric Traction Company, the object of which, we are informed, is to construct electric tramways in Rouen. Since that announcement appeared, we gather from a French contemporary, which quotes from a Rouen paper, that the Société Générale d'Eclairage et de Force Motrice, of Paris, which work the Popp system for lighting and the Conti compressed-air system for tramways, have also approached the municipal authorities of Rouen with a view to a concession being granted for the construction and working of tramways in that town on the Conti system. The Conti system, it will be remembered, was described in our issue of April 20, 1894.

Electric Power in Engineering Works.—In our issue of October 19 we reproduced the presidential address delivered by Mr. T. Richardson before the North-East Coast Institution of Engineers and Shipbuilders. The current issue of the *Transactions* of this institution contains the address and the discussion thereon. In addition to this, photographs are given in illustration of the address. One is of a large straightening machine driven by a 3½-h.p. electric motor at the works of Messrs. Dorman, Long, and Co., Middlesbrough. The second shows a double punching machine actuated at the same works by a 6-h.p. motor. In the third photo is represented a Pieper multipolar flywheel dynamo of 500 h.p., coupled to a compound-condensing Corliss engine, at the National Arms Factory, Herstal, Belgium, whilst the fourth illustrates a row of electric motors driving lines of shafts at the same factory.

Institution of Junior Engineers.—The fourth meeting of this session will be held at the Westminster Palace Hotel, Victoria-street, on Friday evening, 15th inst. Mr. H. J. Young will occupy the chair. The paper to be read and discussed is "The Practical Application of Alternating-Current Motors," by Mr. Walter J. Fryer, A.I.E.E., member. The following is the synopsis: Theoretical aspect of alternating-current system of supply in England—Difficulties of working single-phase motors; frequency, dead points, etc.—Description of Brown and Oerlikon motors; winding and connection of coils—Application of motors to organ-blowing plant; requirements to be fulfilled, advantages of electric motors for the work to be performed, automatic clutch pulleys, reduction gear, self-starting arrangements, object of condenser and resistances, methods of switching. Several motors will be exhibited, lent by the General Electric Company, and will possibly be working.

Electrical Communication with Lighthouses.—This subject was referred to on Monday, by the Earl of Morley, at the annual meeting of the Plymouth Chamber of Commerce. His lordship stated that for the first time they saw that some really useful work had been done in that direction. They might try to persuade the Government to expend the £200,000 necessary for the completion of the work, but he was afraid they would be told by the Treasury that they had other pressing claims on their resources, and that they would have some difficulty in providing so large a sum of money. The matter, however, was a very important one, and he trusted that the Treasury and the Board of Trade might put their heads together and bring about a more rapid development of the telegraphic system between the shore and the lightships and lighthouses. The experience at Eddystone last year, when the "Dunottar Castle" went aground, was, no doubt, a remarkable one, but it brought vividly before them the dangers which great ships ran on account of the rocks around our shores, and the great value which immediate communication with the shore would be in saving life.

"D.P." Storage Batteries.—A few weeks ago we described the new type of "D.P." cell brought out by Messrs. Johnson and Phillips, of London and Charlton, for the electrical illumination of railway trains. Since then the firm have issued a new illustrated price-list of the "D.P." storage batteries, of which they have supplied during the past few years cells which if placed in a continuous line would reach a distance of six miles. It will be remembered that these accumulators, which are arranged either in glass or wooden boxes, combine the durability of the Planté cell with the capacity of the pasted form. The plates afford a large working area and the cells can be charged and discharged at high rates without the bringing about of any disintegration or buckling. Messrs. Johnson and Phillips now pay carriage on these accumulators to any part of Great Britain, this being equivalent to a great reduction in price. Durability being the predominant feature of the battery, this word will in future always be associated with it. The discharge rates of the cells are now nearly 20 per cent. better than formerly, whilst the renewal rates are common to the "D.P." or

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pasted form of cells—*e.g.*, the firm renew either their own or other makers' cells at the same rate.

London County Council and Traction.—Writing to the *Pall Mall Gazette* from the National Liberal Club, Mr. Joseph Nelson says: "I went to witness the proceedings of the London County Council upon the application of a tramway company for permission to introduce the electric system of traction for about one mile within the jurisdiction of the London County Council. After listening to the speeches against the innovation, I said to myself, Am I living in the year 1835, when I began my first railway survey? For through all the intervening period I have never listened to such senseless objections as those which were uttered. My experience extends to the evidence before thousands of committees of the Lords and Commons; but, above all, the most violent and unfounded statements were those made by Mr. John Burns. If he is a sample of the Progressives of the County Council, I shall not be surprised if that section meets with a severe reverse in the coming election. I have no interest whatever in the company that applied for the permission, but I have a deep interest in seeing the perfect success of the tramway system in the United Kingdom, of which I was one of the first authors."

Transmission of Power at the Sheba Mines.—An interesting example of the electrical transmission of power is being carried out by Messrs. Johnson and Phillips, of London and Charlton, at the Sheba gold mines, 10 miles distant from Barberton, South Africa. This installation is described in an illustrated pamphlet issued by the firm. Hitherto the ore has been conveyed to the stamps, a distance of three miles, by means of an aerial tramway, but the development of the mines has been so great that the directors of the Sheba Gold Mining Company decided early last year to lay down additional stamps not on the site of the then existing stamps, but at the mine itself, and to transmit the power for working them by means of electricity. The electrical energy is transmitted through five miles of underground cable, curving round the hills from the Queen's River. The available water power is estimated at 600 h.p., and two 300-h.p. turbines have been laid down for driving the generators. The power-house, which has been built on a slope by the Queen's River, contains two alternators, and the current is transmitted to the receiving-house at the mine. Here the pressure is reduced by means of transformers, and the electrical energy is conveyed by other cables to different points for the operation of motors working the stamps, pumps, settlers, breakers, etc. In a future issue we hope to refer again to this important installation.

Society of Engineers.—The president for 1894 (Mr. G. A. Goodwin), who occupied the chair at the opening of the first meeting of the present session at the Westminster Palace Hotel on Monday evening, presented the premiums awarded for papers read during that year—namely, the president's gold medal to Mr. T. W. Baker for his paper on the "Utilisation of Town Refuse for Generating Steam"; the Bessemer premium to Mr. E. C. de Segundo for his paper on "Power Distribution by Electricity, Water, and Gas"; the Rawlinson premium to Mr. R. Nelson Boyd for his paper on "A Deep Boring near Friestadt, Austria, by the Canadian System"; and a society's premium to Mr. H. B. Ransom for his paper on "The Principles and Practice of Hydro-Extraction." Mr. Goodwin introduced the new president (Mr. W. G. Peirce) to the meeting, and retired from the chair. The new president, in his address, referred to the progress of electric traction as shown by the City and South London Railway and the Liverpool overhead line, the successful working of which, he said, had paved the way for the Waterloo and City electric line, of which he gave particulars. As for the explosions which had occurred in underground systems, he thought there could be little doubt that in most instances they were caused by a leakage of coal gas, fired by a spark from the electric cables, which had for some reason or other become short-circuited.

Electric Traction in Germany.—The Minister of the Interior has approved of an electric tramway being laid from Leipzic to the suburbs of Mockau, Schönefeld, and Grosseschocher.—The owner of Hafkrug, a Baltic watering place, proposes to connect a new hotel which is now being built with Glesehendorf railway station by means of an electric tramway.—A committee of the Berlin Municipality which visited Deutz to examine the Langen overhead suspended railway system, recommend that a concession should be granted for one of the lines which Mr. Langen is desirous of building. They report that what they saw at the works impressed them favourably.—The local authorities of Reichenberg have granted a concession to Messrs. Schuckert and Co., of Nuremberg, for an electric tramway there.—At Bochum the Municipality have decided to build an electric tramway from the Bergisch-Märkisch railway station to the starting point of the Herne electric tramway, which was opened a few weeks ago. The work will be entrusted to Messrs. Siemens and Halske. Electric traction has been introduced on the horse tramway line between Rathhausmarkt and Einsbüttel, Hamburg.—The Munich local authorities have approved of electric traction being adopted on the Färbergraben-Isarthalbahnhof tramway line.—An arrangement has been come to between representatives of the Municipality and the Hanover tramway company whereby accumulator traction is to be introduced on all the lines of the company within a period of five years.

Electric Hot-Plates for Restaurants.—We are glad to learn that electrical hot-plates are now being supplied to hotels, restaurants, etc., for keeping food warm when supplied to the customers. Messrs. Crompton and Co., the makers, state that one restaurant in the West-end is now proposing to adopt the system of supplying an electric hot-plate to each customer on which to stand dishes containing the food. With the usual system the plate gets gradually colder and colder, and the latter part of the course is seldom so satisfactory as the first; but the electric hot-plate rectifies this defect. Some restaurant proprietors who do not see their way to supply the hot-plate free to their customers propose making a charge of 1d. for its use. It is found that a circular hot-plate 8in. in diameter may be maintained at a temperature of 212deg. at an expenditure of one ampere at 100 volts. This would cost less than ½d. per hour. There appears to be considerable scope in this direction, and the durability of the plates should be very great, as they are not strained in reaching the above-mentioned comparatively low temperature. Another system is sometimes adopted—that of using a quick-heating plate which is connected when the order is given. The plate becomes hot in a couple of minutes, and is then used in the same manner as a hot-water plate. In the latter case no connecting wires are required on the table, the plate being previously heated from some convenient spot. It is found that the plates retain their heat for a considerable time.

Electricity in the Production of Wine.—In *L'Electricien* of the 2nd inst. is given an illustrated description of a combined electric light and power plant in use at the wine-producing establishment of MM. Pech and Baudoin at Abziza, Algeria. The idea of putting down the installation arose from the fact that it was found that electrical plant

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would be the most serviceable for placing under the control of the Arabs employed in the establishment. The generating plant comprises a compound dynamo and a steam-engine, the current from the former being utilised for lighting purposes and for actuating seven electric motors of powers ranging from two to ten effective horse-power. One of the motors drives a one-ton crane, which is used for lifting boxes of grapes from the ground floor to the beating-room; three motors operate the beaters and presses, and the remaining three are coupled direct to centrifugal pumps, which circulate the must in the tuns. The work of the electric motors, and consequently the load on the generating dynamo, is extremely variable. It might therefore be expected that variations in the speed of the steam-engine and also in the luminosity of the lamps would take place. This difficulty has, however, been overcome by using a compound dynamo and by the perfect regulation of the steam-engine. In the case of the pumps driven by electric motors, it may be mentioned that each set is arranged on a small trolley running on a narrow-gauge line, the current being conveyed to the motor by a flexible cable. The installation, which was carried out by Messrs. Sautter, Harlé, and Co., was supervised by M. Baudoin.

Decimal Weights and Measures.—Various resolutions will be submitted at the forthcoming annual meeting of the Association of Chambers of Commerce to be held on March 12, 13, and 14. One, a London proposal, is to the effect that the association learns with satisfaction of the willingness of her Majesty's Government to appoint a select committee for the purpose of ascertaining whether any, and if so what, changes have now become necessary in the British system of weights and measures, and in order to give full effect to the repeatedly and unanimously expressed opinion of this association in favour of the adoption of the metric system of weights and measures, the executive council be requested (*a*) to collect evidence from members of the association with a view of placing the reasons for the desired reform forcibly before the intended committee; and (*b*) to secure the introduction of a Bill for the amendment of the Weights and Measures Acts with the object of removing doubts as to the legality of traders engaged in export business possessing and using metric weights and measures for export trade purposes, provision for the verification and stamping of which—on comparison with the Board of Trade metric standards—is already made in those Acts for the purposes of science and manufacture. A second resolution, emanating from Leeds, suggests that, having regard to the repeated demands of the commercial community for the adoption of a decimal system of weights and measures in place of the present complicated and irregular system, which is found to hamper trade and retard education, and having regard also to the practically unanimous desire expressed in favour of the metric system now in use in most foreign countries, the executive be urged to take immediate steps to bring about the change, and, if considered advisable, to secure the introduction of a Bill into Parliament during the next session providing for the permissive use of the metric system for two years, after which time it shall become compulsory.

Pacific Cable Question.—The Inter-Colonial Postal Congress, which met at Hobart on Friday and Saturday last, discussed, among other matters, the question of the Pacific cable. Mr. Thynne moved a resolution in favour of the construction, working, and maintenance of a cable, through British territory and under British control, from Vancouver to Australia, to be undertaken by the Governments of Great Britain, Canada, and Australasia, and the cost to be borne equally by the three countries. The route proposed was from Vancouver by Neckar Island to Fiji, and thence to Caloundra, in Queensland. If Neckar Island could not be placed under British control, the route would be by Fanning Island instead of Neckar Island. The motion further advised that a commission of the three countries should be appointed to conduct the financial arrangements, and that the Government of Canada should be requested to continue their good offices in promoting the undertaking. Mr. Cook moved an amendment reaffirming the desirability of a Pacific cable, and urging the Governments to take steps in the matter. The amendment was carried. In regard to the cable guarantee, Mr. Ward moved that Victoria should reconsider its withdrawal. The conference went into committee to confer on this point. As the result of the consultation, Mr. Ward moved before the conference that the colonies should agree to guarantee an international revenue to the Eastern Extension Telegraph Company up to £227,000 per annum, making up any loss below that amount, provided it did not exceed £10,000; also to guarantee a revenue from the New Zealand cable of £20,000, making up the loss if it did not exceed £9,000, provided the rates were not higher than at present; the agreement to be from year to year and terminable on two months' notice. The arrangement is to be referred to Sir John Pender for approval. The conference has since resolved that the committee should further consider the cable guarantees and Sir John Pender's reply regarding the proposal made by the conference in the resolution of Saturday.

Effects of Strong Electric Currents. — M. Bernhardt, in the *Centralblatt für die Medicinischen Wissenschaften*, has collected several instances of death by electricity. In one recorded by Dr. J. Kratter, as quoted by the *Lancet*, a man aged 26 was traversed by a current of high tension—1,600 to 2,000 volts—and was found breathing stertorously a few steps from the point where he made contact. Death soon took place. The post-mortem examination, after the lapse of 21 hours from the time of death, disclosed two small wounds—one on the left index finger, and the other on the back—and there were large extravasations of blood in their vicinity. All the organs of the body showed hypervenous blood, acute œdema of the lungs was present, and there were extravasations into the sheath common to the cartodid and vagus, along all the vertebræ, into the intercostal spaces, around the œsophagus, beneath the peritoneum and elsewhere. The muscles of the body were in an extreme condition of rigor mortis. The heart was partially relaxed. No macroscopic changes could be seen in any part of the nervous system. Kratter thinks that the electrical shock suddenly paralysed the heart, which was the immediate cause of death, accompanied by œdema of the lungs, causing hypervenosity of the blood. There was a marked contusion on the left side of the diaphragm at the point of contact of the heart. Experiments made on animals showed that in them the respiration was usually primarily arrested, which caused asphyxia and secondary stoppage of the heart's action, though sometimes the heart was first affected. In a second case, reported by M. D'Arsonval, a man was struck with a current of 4,500 volts (the ampere-meter indicated 750 milliamperes). The current entered at his hand and issued at his back. Half-an-hour or more elapsed before any attempts at resuscitation were made, but on artificial respiration being practised on Silvester's method recovery took place. Lastly, Dr. Donnellan reports a case of the passage of a current of 1,000 volts through a man, which instantly caused coma, dilated pupils, pallor of the face, and sweating; delirium, and tonic alternating with clonic spasms, followed. The pulse was 80. The

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respiration, at first stertorous, passed into the Cheyne-Stokes type. After the injection, first of morphia and then of strychnia, the patient fell into a deep sleep, from which he awoke convalescent.

Electric Light v. Gas.—A correspondent writes to the *Colliery Guardian* as follows: "If the electric light supersedes gas for illuminating purposes, the manufacturers of gas cannot ascribe any of the blame to the high cost of their raw materials, for, as a matter of fact, their expenses of production are much below their receipts; so much so that there is scarcely a gas company in the country which does not pay to its shareholders a heavy dividend, whether general trade is depressed or not. Ten per cent. is a very common dividend declared by gas companies even in such times as the present, and we hear of them, in addition to this, turning over large amounts to reserve funds, whereas those who supply them with materials, particularly coal, have to be content with little or no dividend, and yet the gas companies press for lower prices of coal, though they are obtaining the fuel now for less money than was ever before known. As a rule, amongst themselves there is no competition; each company has its own field, with no one to dispute its monopoly, and so the price of their gas can be kept up, but among the coalowners the case is very different, and competition being very keen, the prices are cut down to extremely low figures, greatly to the benefit of the gas companies. In Durham, however, some thirty-four of the owners of the leading gas-coal collieries have formed a syndicate to resist the persistent pressure put upon them by the gas corporations, and it would be well if their brethren of other districts would follow the example. By their greed for big dividends the gas companies are hastening the time when their light will be superseded by something better, and they are stimulating inventors to devise cheap and efficient substitutes. Thus they are playing into the hands of their rivals, and must eventually ruin their trade, and with it the coal trade must severely suffer, because so much coal is now raised solely for gasmaking purposes. Probably the gas companies are working for the present only, foreseeing that the electric light is the light of the future, and that if they want profits they must secure them now and let the future take care of itself."

Telegraphy in East Africa.—Some misunderstanding appears to have prevailed in colonial circles in Berlin, as to the negotiations which were carried on between Germany and England on the subject of Mr. Rhodes's proposed line of telegraph. A *Times* correspondent states that the course of the negotiation was as follows: The British Government sounded the German Government as to whether it would be willing to grant facilities for the laying of a line of telegraph through German East Africa. The German authorities treated this question, it is admitted, in a dilatory manner, and finally returned an evasive answer—not from any illwill towards England, but from a natural anxiety as to the possible consequences of the execution of Mr. Rhodes's scheme if their assent were given. As, they argued, the line would pass through a wild part of their territory, it would be absolutely necessary for Mr. Rhodes to erect stations for its defence, which in the long run might have to protect the wire by force of arms. This consideration appeared to the German Government to be sufficiently weighty to justify a reserved attitude. While matters were still at this stage, the German Government was approached on the subject from another side. A delegate of the South-West Africa Company entered into negotiations with the colonial authorities, and proposed that if the Imperial Government could not consent to the original suggestion for the laying of a line of telegraph through its territory, to be under English management, it would, perhaps, not object to the formation of a German company which should be floated with English capital and should control the telegraph on German soil. For this purpose, however, Germany was requested to grant concessions of land on both sides of the wire. To this plan, again, Germany could not consent. The correspondent has the best grounds for believing that these statements, so far as they go, are correct. It will be seen that those circles in which it was asserted that Mr. Rhodes had demanded fortified stations were evidently of opinion that the objections raised by the German Government referred to a definite request. Further, Mr. Rhodes was not personally concerned in the negotiations, though it was assumed that the delegate of the South-West Africa Company was acting in his interests. That this gentleman emphasised the necessity of concessions of land on both sides of the line of telegraph is firmly maintained.

Rapid Transit in New York.—A report by Mr. Parsons has been presented to the New York Rapid Transit Commission on some of the engineering features and cost of the proposed electric railway under Broadway. The principal difficulties lie in the part of the line below Fourteenth-street. Here the rock lies at a considerable depth, and over it are beds of unstable sands. The great buildings which line Broadway and the sidewalk vaults, which would have to be cut into in case a four-track road near the surface were installed, complicate the problem greatly. The construction of a four-track line as shown on the plans without disturbing the surface of the street, involves tunnelling methods that are without precedent. The success of such methods is entirely problematical, and the great risks to all the interests involved do not justify their consideration. The only practical method by which such a road can be constructed would be by open cut, although the objections as to requiring underpinning of the abutting buildings and the invasion of property right would still remain. Mr. Parsons suggests, instead of building under Broadway below Fourteenth-street, a four-track railway from Union-square through New Elm-street to the City Hall, and thence a two-track line through Nassau and Broad streets to the South Ferry. This could be supplemented at any time, if desired, by a two-track line from Union-square through University-place, Greene and Church streets to the City Hall. Since the express trains would make no stops between Fourteenth-street and the City Hall, a two-track line on Church-street would give the same accommodation between those points to the territory west of Broadway that the four tracks do to that east of Broadway. If, however, the committee desires to adhere to the Broadway route, he suggests the treatment of the local tracks and the express tracks as separate railways and the construction of each independent of the other, so as to obtain the maximum of efficiency for both. The former would naturally follow the undulations of the street as closely as possible in order to have a minimum depth at the station platforms, while the express line should have shallow stations at long distances, and between these stations be run on more favourable gradients. By the plans submitted, the railway would be constructed by taking one-half at a time, laying the side walls in a trench and then turning half the arch. The other half of the tunnel would be completed later. All the material beneath this arch could be excavated after the latter was completed and the street surface restored. The lower tunnel could be constructed by means of circular shields, and as these would be driven beneath the masonry tunnel previously constructed, there would be little danger of a movement of the ground sufficient to affect the street surface.

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THE PREVENTION OF EXPLOSIONS IN CONNECTION WITH UNDERGROUND MAINS.

Will those gentlemen who have not already replied to our questions on this subject kindly send in their answers as early as possible? The following have been received during the week:

Aberdare.

The two lines published under this heading in our last issue referred, not to Aberdare, but to the Ogmore Valley station.

Scarborough.

Mr. GERARD S. PECK, of the Scarborough Electric Supply Company, Limited, reports that no trouble has been found through the accumulations of gas. The company have a special engine driving a blower, which forces a current of air through the pipes. This method has been quite satisfactory. The mains are made watertight, and any water could be removed at the boxes; but after 17 months' running very little trouble has arisen.

Whitehaven.

Mr. J. W. BRODIE, the engineer of the Whitehaven Corporation electricity works, has experienced no trouble in connection with accumulations of gas. No necessity has arisen for providing against the possibility of explosions. He regards good ventilation of the surface covers as the most practical method of overcoming explosions. The culverts are drained into the sewers and trapped. No trouble has been caused by electrolysis.

Major-General C. E. Webber

has not experienced any difficulty in regard to explosions of gas. The difficulty has been overcome by constructing the culverts in such a manner that gas cannot leak into them except through the negligence of the persons in charge. This method has been successful. When practicable, General Webber ventilates the street boxes and transformer-chambers, but he states that it is not always practicable to do so. With regard to the prevention of explosions, he observes that explosions cannot take place in a conduit, in pipes, or cable-ways when one cable is drawn in and the space round the cable where it enters a box caulked with spun tarred yarn. From the earliest days he has always advocated that each conductor should have a separate way. If these conditions are existent, explosions within a conduit, pipe, or way is practically impossible. Concerning drainage, he states that draining should not have to be thought of in a well-laid conduit, pipe, or way, but in practice he always has them laid with a fall each or either way to the nearest box. Spare "ways" should always be plugged up at each end. General Webber has not the least hesitation in stating that if the precautions described in his paper on the City of London electric lighting in February, 1894, are complied with, there is no risk to that system, in which each conductor has a separate way.

THE NEW-MAYNE ELECTRIC RUDDER MOTOR.

A new type of electric motor suitable for small pleasure boats has been recently brought out by Messrs. New and Mayne, electrical engineers, of Palace-chambers, Bridge-street, Westminster, and of Woking.

The makers had long thought that it would be a great advantage to all owners of pleasure boats if they could obtain a type of electric motor which could be easily adapted to any ordinary rowing-boat, without the necessity for structural alterations. One of the great obstacles to the extended use of the ordinary types of motor arises from the fact that either an entirely new boat must be ordered, specially fitted with electric apparatus, or such expensive alterations are needed in the case of the ordinary rowing-boat as to dissuade many persons from undertaking the work. The makers considered that if some type of motor could be so built and enclosed in a suitable case as to act both as motor and rudder that it could then be attached to the boat by the ordinary fixtures used for the rudder, and could thus be easily shipped and unshipped. The chief difficulty met with was in the design of the motor, which must necessarily be very light and compact.

The final type arrived at is illustrated in Figs. 1 and 2, in which Fig. 1 is a side elevation, and Fig. 2 a plan of the whole apparatus ready to be put upon the stern of the boat.

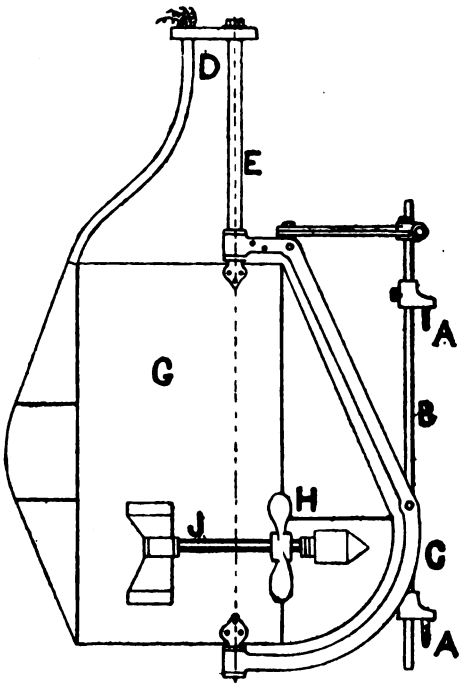

FIG. 1.

The particular size illustrated is adapted for a double sculler, which is the type of boat most commonly used on the Thames. The whole weight of the apparatus is carried by the two eyebolts on the stern of the boat which serve to support the ordinary rudder. The spindle, *b*, carries two adjustable pins, *a a*, which can be moved so as to suit any boat. The double-bent frame, *c*, is provided top and bottom with bearings, in which the top bar, *e*, and the bottom pin, *f*, can swing round. The motor itself is enclosed in a watertight brass case, *g*, which is provided at the end with separate covers, so that the brushes can be examined. The armature shaft is provided with a bevel wheel which gears into a similar bevel wheel keyed upon a vertical spindle inside the case near

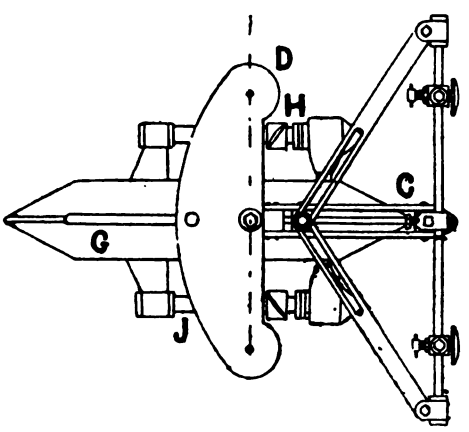

FIG. 2.

the stern of the boat; this spindle has at its lower end a second bevel wheel which gears with another upon a horizontal cross-shaft, and the latter drives by bevel gear the two propeller shafts. The boat is thus driven by twin screws. It will be seen that the whole of the case is free to swing about the top and bottom pivots so as to act as the rudder; an ingenious method has therefore been adopted to obtain stability when the boat is in motion. The propeller shafts are both hexagonal in cross-section, and the propellers are free to slide along them; it therefore follows that when the boat is travelling ahead the propellers are

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working against one bracket, and when travelling astern are acting against the other.

The commutator is at the stern end of the case, and is provided with carbon brushes of square section, pressed against it by means of springs bent into a zigzag form. The armature itself is 3in. diameter, and the commutator 2¾in. diameter, in the size known as No. 1 type, and intended for a double sculler.

The field magnets consist of flat soft-iron plates bent into a suitable form so as to surround the armature, as shown in Fig. 3, and the winding is of the shunt type. The leads are carried up through the pipe which is connected to the rudder yoke, and they form the yoke lines used for steering, and pass to the secondary battery, which consists of 12 cells in two separate boxes. The cells are of the type made by the International Electric Storage Company, the plates being pasted on grids; they resemble the Theryc-Oblasser cells to some extent, and the plates are in celluloid envelopes. Each battery-box is of such a size as to go under the seat used for rowing, and the two boxes are connected

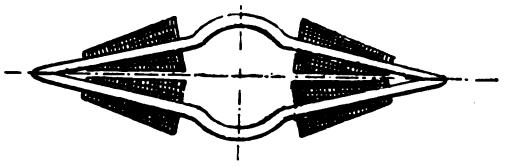


FIG. 3.

by concentric cable. Each cell has 11 plates, and the total weight of the battery is stated to be 112lb.; the motor at present weighs 60lb., but the makers are about to construct one which will weigh only 50lb. The external dimensions of each battery-box are 16in. long by 12in. wide by 6½in. high. When fully charged, sufficient energy is stored to run a boat containing four persons for eight hours. The speed of the armature when the machine is run in air is 2,000 revolutions per minute, giving a speed of 1,200 revolutions for the propellers, while in water the speed of the propellers is from 900 to 1,000 revolutions per minute. With four persons in a double sculler of ordinary type, the speed obtained in still water is said to be from four to five miles per hour.

One of these motors is at present on view at the yachting exhibition in the Aquarium. It is shown at work in a glass case filled with water. The adaptability of this motor to all ordinary rowing-boats, without necessitating structural alterations, appears to be a great point in its favour, as it can be hired out by boat proprietors.

THE DETERMINATION OF THE DRYNESS OF STEAM.

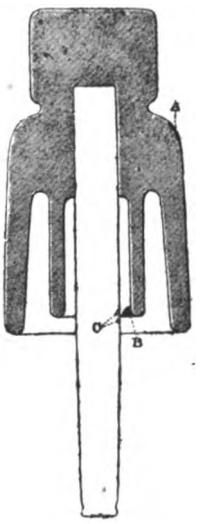
This subject was discussed before a meeting of the Institution of Mechanical Engineers last week in a paper presented by Prof. W. Cawthorne Unwin, F.R.S. Having described the various systems of ascertaining the dryness of steam, the author arrived at the following conclusion:

Generally, the author thinks, that the wire-drawing calorimeter without separator is the most convenient and accurate for steam with less than about 2 per cent. of moisture. For steam containing more moisture, the separating calorimeter without wire-drawing apparatus is accurate enough and convenient. The use of the separator and wire-drawing calorimeter combined is more troublesome, especially if, as is desirable, a condenser is also used to determine the amount of steam passing through the separator. In cases where there is much priming, it would seem best to take the whole of the steam through an ordinary steam separator, measuring the amount of water trapped, and then to test by a wire-drawing or separating calorimeter the dryness of the steam after passing the separator. In priming, much of the water probably flows along the bottom of the pipe, and it appears impossible that a sample can be obtained containing an average proportion of steam and water. It is recommended by Prof. Carpenter that the sample of steam to be tested should always be taken from a vertical, not from a horizontal steam-pipe. No doubt there is rather more tendency for water to flow along the bottom of a horizontal pipe than down the sides of a vertical pipe, but merely taking steam from a vertical pipe does not ensure freedom from error, especially if the amount of moisture in the steam is considerable. Variations in tests for wetness are doubtless often due to the difficulty of getting a true average sample of steam, and it would seem that errors are generally in the direction of underestimating the amount of moisture.

LIGHTNING AND TELEGRAPH INSULATORS.

The following case of lightning happened on the telegraph line between Bombay and Bhusaval in October last. Mr. P. V. Luke, director of the construction branch (Indian Government Telegraphs) has sent the appended note, which is given in the current issue of the *Journal*, on the subject to the secretary of the Institution of Electrical Engineers.

One of the iron wires was broken, and the cause put down to lightning. As no insulators were smashed, the local superintendent, Mr. Kenyon, called for the ends of the wire, and had two of the white porcelain insulators on each side of the break removed for examination. Of the four insulators, one was cracked and the stalk loose.



The other three appeared to be entirely undamaged, except that each had a little brown mark at the edge of the inner cup, in the position marked B in the accompanying sketch; and on each stalk, at C just opposite, was a small mark about the size of a pin's head, with a little conical point in the centre, where the flash had apparently sparked across. There was also a brown mark at A where the wire binder touched the insulator. At each brown mark the glaze of the porcelain was destroyed, being reduced to a powder which disappeared in water. The three apparently undamaged insulators were tested after being immersed in water for 24 hours, and each gave an insulation resistance of over 5,000 megohms. If the lightning went through the porcelain it would assuredly have destroyed the insulation; failing this, it must have passed over the whole surface of the porcelain to get from the line wire to the edge of the inner cup—which seems curious.

BRUSH CENTRAL STATIONS.

A handsome quarto-page pamphlet has been issued by the Brush Electrical Engineering Company, Limited, of 49, Queen Victoria-street, E.C., in illustration of the company's construction and installation of heavy electrical plant for central-station working. That the Brush Company occupy one of the leading positions in this branch of work goes without saying, and this fact is brought home

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very forcibly to the mind by a perusal of the descriptions and by an inspection of the illustrations, contained in the pamphlet, of electricity works equipped by the company. The *brochure* details the central stations at Huddersfield, Hanley, Lancaster, Worcester, and Windermere. These do not, however, in any way imply the extent of the company's operations in this direction, but are only described by the aid of excellent photo-litho illustrations as typical examples showing the nature of the work. Thus, for instance, alternate-current steam-driven plant is installed at Huddersfield, where a Victoria motor operates an overhead travelling crane, and at Hanley the plant comprises alternate and direct current steam-driven machinery. The Lancaster station is equipped with direct-coupled dynamos. Coming to Worcester, one finds here the first example in this country of the utilisation of water power on a large scale in conjunction with turbines and steam-driven alternators; whilst at the same time alternating-current motors of 30 h.p. are used for driving a set of pumps at the waterworks. At Windermere the plant laid down also comprises alternators actuated by turbines, this being the first instance of the application of water power to the public supply of electricity. A glance at the map which follows shows that the Brush Company have established no less than 28 central stations in the United Kingdom—truly a remarkable record of progress. We must, however, not omit to mention that the company have also equipped the largest and most important central station in the country—namely, that on Bankside, from which the City of London Electric Lighting Company are supplying light to the greatest city in the world. The pamphlet, which also contains a list of numerous central stations carried out by the company in nearly all parts of the world, is exceedingly well illustrated, and it will be preserved by all who are fortunate enough to secure a copy.

AN ELECTRIC CARRIAGE IN PARIS.

A note concerning the use of his type of secondary battery for traction purposes has been kindly forwarded to us by M. D. Tommasi, of 44, Rue Jacob, Paris. He states that the trap equipped with this type of accumulator somewhat resembles a petroleum-cart, but that there is no mechanism visible. The battery is arranged behind the seat of the carriage, under the body of which a small motor is fixed. The carriage is provided with a powerful brake. It will be remembered that the Tommasi cell differs from other oxide of lead accumulators in the sense of being specially constructed. Each electrode is formed of a celluloid frame perforated by numerous holes, filled with active material, and in the centre is placed a lead core, which serves as the conductor for the current and not in any way as a support for the active material, as in other types of secondary batteries. This arrangement renders impossible, according to M. Tommasi, the disintegration of the electrodes and the falling of the active material. The electrodes of the same kind are soldered together to a connecting bar, and are separated from the adjoining electrodes by means of vertical rings made of celluloid. The case is of wood, lined internally with celluloid, and closed at the top by a tight transparent cover. The accumulator formed in this manner is compact and light, and its capacity is about 25 ampere-hours per kilogramme of electrode. The battery is claimed to be unaffected by shocks and vibration, and sustains, without inconvenience, extremely high rates of discharge. The trap already referred to is equipped with 21 cells, each weighing 13 kilogrammes 300 grammes, and contained in seven boxes. These cells are connected in series, and are capable of discharging on an average 100 amperes at 40 volts. On starting, and on steep gradients, the discharge rises to 200 amperes. Under these circumstances, the battery works for an hour and a half, which corresponds to a capacity of

7·5 ampere-hours per kilogramme at low discharge
11 „ „ „ „ „ average „
15 „ „ „ „ „ maximum „

Under more reasonable working conditions the capacity would be much higher—that is to say

22 ampere-hours at the rate of 1 ampere per kilogramme
18 „ „ „ „ „ 3 „ „ „
15 „ „ „ „ „ 6 „ „ „

The total weight of the trap, including passengers, is about 1,200 kilogrammes, or, say, 24cwt., and the speed attainable is 20 kilometres (12·4 miles) an hour. Both stopping and starting of the carriage are easily accomplished. M. Tommasi states that the elasticity of his accumulators combined with their great capacity forebodes well for the future success of electric traction on roads.

ARC LIGHT CARBONS.*

BY B. F. MILES.

(Concluded from page 108.)

We have now reached what is called the "green carbon" stage of the process. The carbons appear a shiny black in colour, are quite heavy, break easily, and when held by the fingers and tapped together, give forth only a dull sound.

Both moulded and forced carbons are next taken to the furnace-room, where the volatile matter contained in them is driven off. This is a process requiring great delicacy in handling combined with absolute thoroughness. If they are baked too rapidly, they warp and so are unfit for trimming. If they are not baked sufficiently, they are too low in conductivity and give a very poor light.

In the early days of the art baking was accomplished by placing each carbon in a mould or crucible, and heating many crucibles in a large retort. This very expensive process was soon superseded by baking in fireclay pots or seggars, many of which can be baked together in a furnace resembling a pottery kiln. This is the process followed by many foreign manufacturers. In this country the almost universal practice is laying the carbons in a large rectangular furnace, layer upon layer, each separated, in a bed of sand, the entire mass protected by a covering several inches in thickness, over which the heat plays until every carbon has reached a high temperature. Just what temperature this is, measured in degrees, has never been accurately ascertained. It is supposed to be between 2,000deg. F. and 3,000deg. F. Few realise the time required in baking alone. It seldom happens that large furnaces are "turned" within two weeks.

There are several methods of applying heat, both to calcining retorts and baking furnaces. The simplest construction consists of a fire-box in which coal or natural gas is burned and the heat carried over the mass of carbons in a single direction.

Mr. Lawrence has invented a modification of the Siemens-Martin reverberatory process for steelmaking which gives the highest results. Bituminous coal, rich in gaseous products, is converted into fuel gas. This is conveyed hot into the furnace itself through firebrick flues, first by one end, next by the other, where, mixed with air, it burns with an intense flame. During the two or three days of highest combustion, the interior of the furnace glows like the face of the sun at noon, but at the same time the heat is under most perfect control.

From the furnace the carbons are carried to the sorting tables, where, rolled on steel plates of true face, the straight are separated from the crooked. The former are taken into the plating-room, where they are given a thin coating (usually) of copper, which increases their conductivity and prolongs their life. The latter are sorted into various grades: some are sold as seconds, others are cut into short lengths, others are rejected. It is a very interesting sight to see the packing boys wrapping the carbons in paper for shipment. Few machines surpass their agile fingers in rapidity of movement as they roll single carbons into blocks of five, and blocks of five into packages of 25. The latter they place closely together in wooden boxes of a thousand capacity, and when the nails of the lid are driven down the carbons are ready to be carried by rail or water to any part of the civilised world.

* *The Electrical World.*

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There remain two or three points of interest to students of social science and statisticians.

At the beginning of the modern carbon industry in 1878 nearly every one of its 30 to 40 processes was accomplished by unaided hand labour. In 16 years this condition has been completely reversed. Hand labour now exists only in four processes, and in the coming year these will be greatly assisted or accomplished wholly by labour-saving devices.

Such economies are only possible where the business is carried along on the largest scale. In such a concern the responsibilities thrown upon its management are great. The workman whose employment fails should be provided for. This can seldom be done in these days of fierce competition save by increase in quantity, consequent upon the highest quality. It is greatly to the credit of Mr. Lawrence that this is his invariable aim, and that, with his many improvements in processes and machinery, he has been able so to extend the operations of the company of which he is head that it has retained in its service all its worthy employés.

Few industries exemplify better the tendency of our age to concentration. During the past 15 years nearly 75 factories have started in this country and Europe to compete for the production of the 200,000,000 carbons annually consumed. Their combined capacity has probably reached five to six hundred millions per year. At no time has available active factory capacity decreased below 300,000,000 annually. Over half of these factories have died natural deaths. Of the remaining, many have amalgamated with competitors to reduce costs. At present about 25 factories are in operation, with a capacity of 350,000,000 to 400,000,000. Of these, over one-half are unable to find sufficient trade to justify an output of 1 per cent. of the world's consumption. Of the remaining dozen, less than one-half produce nearly 90 per cent. of the grand total.

EARTHENWARE CONDUITS FOR ELECTRIC LIGHT MAINS.

London is not—as may, of course, be readily supposed—by any means the only place where trouble has arisen in electric light supply operations from the ingress of moisture, coal gas, foul air from the sewers, etc., into the conduits for street mains where such are employed: conduits, that is, of the open type in which bare copper mains are stretched upon insulators.

It will be remembered that in the French metropolis one of the principal types of conduits employed—especially for the bare copper mains—is of rectangular section in concrete: and, of course, where this has been properly carried out, there is not much trouble to be feared, the chief danger being from imperfect top coverings, which allow moisture to creep in. In many cases, however, it is impossible to use this form of conduit, owing to the small width of the pathway, already encumbered by the numerous pipes, etc., of other distribution systems. Recourse has been had under these conditions to rectangular conduits in earthenware of considerably smaller sectional area, but practical results show that the pottery conduits thus installed involve serious losses by leakage, with other disadvantages—so pronounced, indeed, that they have now been taken out entirely and replaced by concrete conduits of a size as large as may be permissible in the narrow space under the footpaths. The entire system of one company is thus formed of cement concrete trenches, and satisfactory working at last obtained.

According to M. Monmerque, who discusses the matter in *L'Eclairage Electrique*, the earthenware conduits, however carefully put down and maintained, were positively filled up after a time with white deposits of an alkaline nature, containing, as was proved by chemical analysis, a large quantity of pure sodium—in sufficient quantity, indeed, to burn violently on coming into contact with water.

The causes of such a phenomenon are not clear, though a number of possible reasons have been offered in explanation. One suggestion is that the salt, used very largely in Paris in winter time to melt the snow in order that the streets may be swept clean, is responsible for the damage; but it is objected against this hypothesis that the salt solution is used on the roadway and not on the footpaths, whilst the melted snow and slush is at once swept into the gutters and thence into the sewers, giving no time for soaking through the subsoil. Moreover, fresh water only is used to flush the streets, and the salt would therefore be so diluted that the small quantity which might conceivably reach the interior of the conduits would hardly account for the large deposits therein found. The footpaths themselves are washed down with fresh water only, and this cannot offer an adequate reason.

A suggestion which has undoubtedly some degree of ingeniousness has been made with regard to the conduits themselves. It is thought that the glazing of the interior—obtained, as is well known, by the agency of common salt—may have played a by no means unimportant part in the curious results chronicled. It is, of course, impossible altogether to avoid the entrance of moisture into the conduit, and if electrolysis be set up through slight leakage of current, there might easily result an increasing amount of disintegration in the glaze. A somewhat similar result has been noticed in one of the London distribution systems employing a cement conduit or concrete trench: in this case the negative wires of feeders or potential equalisers were found to be so thickly coated with a whitish mineral deposit as to practically destroy all its insulation. Possibly some of our English earthenware-makers, especially those who have adopted the manufacture of pottery conduits for electric light mains, will be able to criticise the above hypotheses, or suggest others of a more tenable nature.

COMPRESSED AIR VERSUS ELECTRICITY.

A note dealing with the comparative efficiencies of electric power and compressed air was presented by M. Badois to a meeting of the Société des Ingenieurs Civils de France on the 18th ult. The author, in criticising a paper read recently before the same institution by M. de Marchena, said that in order to logically compare electricity with compressed air each system must be considered according to the same transport unit. M. Badois took as his unit a self-contained car having accommodation for 50 passengers. In this respect he showed in the case of electricity that there was not the exact correlation between the elements of information collected by M. de Marchena and the estimates of cost of motive power formulated by him. M. Badois contended that the ratio between the power utilised on the car axle and the motive power indicated in the steam-cylinders at the central station, or, in other words, when the final efficiency in ordinary working was only 25 to 30 per cent. (instead of 30 to 40), the consumption of coal per car kilometre in the case of the self-contained car carrying 50 passengers could not be reckoned at less than 3 kilogrammes to 3·30 kilogrammes (not 2 to 2¼ kilogrammes). The power absorbed on an average per kilometre would be equivalent to about three horse-power hours. These figures, M. Badois stated, are confirmed in the case either of the trolley, accumulator, or the third-rail system, by a careful examination of the practical results cited by M. de Marchena, provided, of course, the results are brought to the unity of transport already referred to. With regard to the use of compressed air for traction purposes, he stated that the theory set forth by M. de Marchena would lead to a final efficiency at the axles of 18 to 20 per cent. only of the power indicated by the steam-engine at the station. But this theory must be transgressed, since the results frequently repeated at Nantes and at Nogent showed efficiencies of between 35 and 40 per cent. M. Badois believed that, instead of considering compressed air as an agency of transforming heat into work, it should be regarded more simply and more exactly as a mechanical spring. The conclusion, M. Badois said, is that one may expect to obtain a final efficiency of 57 per cent. from compressed air, and not 18 to 20 per cent., as limited by the theory advanced by M. de Marchena.

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THE MECHANICAL AND ELECTRICAL REGULATION OF STEAM-ENGINES.

Before the Institution of Civil Engineers on Tuesday, Sir Douglas Fox, vice-president, in the chair, a paper was read on "The Mechanical and Electrical Regulation of Steam-engines," by Mr. John Richardson, M.I.C.E., of Lincoln.

The author dealt with the regulation of steam-engines from the steam users' point of view, and showed how, although many excellent means existed of automatically governing steam-engines to secure regularity and economy, yet in many cases these means were ignored. After laying down the conditions essential for first-class governing, the author reviewed the construction of engine governors, from that invented by Watt to the latest examples, the principal types being illustrated. The advantages and disadvantages connected with each were pointed out, and the unsuitableness of the ordinary pendulum governor for the modern engine, which required controlling with much more certainty and delicacy than was formerly necessary. Moreover, the high speed of textile machinery made regularity an absolute necessity, and the requirements of engines for producing electric light were especially exacting. The type of governor selected as being most suitable was that which combined revolving weights with a spring, and a governor was described which, while of moderate dimensions and weight, had still great lifting and thrusting power, combined with such a balance of its parts that the working sleeve was raised from the lowest to the highest position with but slight variation in speed.

The author next referred to the various kinds of valves for controlling the admission of steam, and their action with the governors. First, the various type of throttle-valves, and the results of experiments in connection with them, and the engines for which they might be properly used. The methods of regulating steam-engines by altering the travel and angle of the main slide-valve, or by limiting the admission of steam by controlling the angular advance and travel of a cut-off slide working upon the back of the main valve, were dealt with. The types of governors suitable for controlling such valve action were described: for instance, those fixed on the crankshaft and revolving with it, and others driven by a belt and gearing at a distinct speed from the crank. Illustrations of this class of valve gear were given, together with copies of diagrams taken from engines so fitted, and the results of experiments as to variation in speed. This gear was stated to be suitable for engines of moderate size, where the working pressure was under 100lb. Tables giving comparative tests taken under equal conditions between engines fitted with shaft governors controlling the slide-valve, and speed governors controlling a throttle-valve were exhibited, showing the advantage of the automatic governor both as regarded regularity and power.

Link expansion gears were next described, in which the main valve had a constant lead, compression and exhaust, and it was the cut-off valve working on the back of the same only which was varied. It was shown that the success of this kind of valve gear depended very much upon the type of governor used in connection with it, which, besides delicacy, must have a wide margin of stability and strength, as considerable power was required to operate the working parts when the engines were of moderate size. The necessity for dispensing with dashpots to prevent oscillation of the governor by the link was insisted upon, and the type of governor which could control such valve gear and maintain perfect stability at all points was exhibited.

The much higher pressures necessary for the most economical use of steam, compelled the employment of valves which would work in equilibrium, or nearly so. These were mainly of three kinds: piston-valves, rotating or circular, like the Corliss, or double-beat valves, slide-valves requiring too great a part of the power of an engine working with high-pressure steam. After alluding to other classes of valve gear, the author described a cylinder fitted with two double-beat admission valves and two gridiron exhaust-valves. It was shown how each of these valves was susceptible of independent adjustment, even while the engine was running, and a simple method of varying the cut-off of the admission valves by the governor was explained and illustrated by a working model. With a valve gear of this kind there was absolutely no strain upon the governor, and not the slightest tendency for it to work or jump due to the working of the valve gear. Diagrams taken from engines fitted with this gear were exhibited, in which the range of cut-off extended from zero to seven-eighths of the stroke, the peculiar advantage of this gear being that it allowed of the engine being instantly stopped from any part of the mill or factory in which it worked.

The electric regulation of engines was next dealt with. The conditions which obtained for an engine driving a dynamo were not quite the same as those for maintaining a constant speed of other machinery; as, if the electric current produced by the engine were used to control its speed, it became possible either to run the engine at a practically uniform speed in connection with a perfectly compounded dynamo or to run it at a varying speed, maintaining either a constant difference of potential with a varying current or a constant current. Further, it was shown that by utilising the changes in the current to control the engine, it was possible when the load was suddenly decreased to effect what was impossible with a speed governor—namely, to shut off for a time the whole of the steam supply before the engine had had an opportunity of increasing its speed. A number of appliances which had been devised during the last 15 years and tested for electrical regulation were described, some as examples of what should be avoided, and others as successful. In most of these latter a solenoid, the core of which was held in a varying position within it by the current, was connected in different ways to the valves. Two forms of electric motors for altering the position of valves were also shown, and other forms of relays. The advantage of the direct connection of the solenoid was very great over any other form of relay.

The paper concluded with a description of a method of electric control of a valve gear which was suitable for engines of large size, the power required to govern the lever being practically nil, a small solenoid and a slight current being found sufficient to effect the entire control of engines up to 1,000 h.p. An automatic method of stopping or slowing the engine, should there be an accidental breaking of the governor circuit, was also illustrated by drawings and working models.

THE GENEVA ELECTRIC TRAMWAY.

During the past five months an electric tramway service has been provided at Geneva by the Compagnie Générale des Tramways Suisses, who entrusted the work of equipping the lines to the Compagnie de l'Industrie Electrique, of Geneva. The tramway, which has been laid in the most frequented part of the town, puts into direct communication the aristocratic quarter of the Bastions and the Place Neuve with the Cornavin railway station; and in the suburbs it extends as far the Champel Plateau on the one hand and to the village of Petit-Saconnex on the other. The total length of the route is about 3½ miles. Besides this, a double line, one mile long, connects the Place du Theâtre with the depôt, situated at Cluse, near Carouge. The former is a single line with turn-outs at suitable intervals. The generating plant has been erected in the municipal central station of the Forces Motrices du Rhône. There are two self-exciting Thury dynamos coupled direct by means of Raffard flexible couplings to two turbines of the Piccard horizontal type. One set of machines is sufficient for dealing with the present service, the other set being kept as reserve. Each generator is a compound dynamo, capable of giving 150 kilowatts at a speed of 365 revolutions per minute. Leaving the distributing and regulating boards, the current is conveyed by means of an underground cable to the central part of the tramway system. From here the current is divided, one part going in one direction and the other in the opposite direction. Connections are made at intervals with the overhead trolley wire, lightning arresters being provided at each junction.

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In the town the trolley conductor is formed by a galvanised steel wire, 7mm. in diameter, so as to render it capable of withstanding any test it may have to contend with, and in the open it is of copper. The trolley wire is arranged in the middle of the thoroughfares, either on standards at a height of 20ft., or is supported by means of transverse span wires fixed to posts on the pavement or to brackets attached to the walls. The return is formed by the rails assisted by a supplementary copper wire connected to them at intervals. The track in the town is formed of Marsillon rails laid on wooden sleepers; elsewhere, Phœnix rails are used. The gauge is 4ft. 10in., the maximum gradient is 55mm. per metre, and the minimum radius of the curves is 25 metres. There are eight cars in service, each capable of accommodating 32 passengers, and each being equipped with a motor of either 15 h.p. or 20 h.p. The speed is 7½ miles in the town and 12 miles in the suburbs. The tramway has met all the requirements of the locality.

THE INCANDESCENT LAMP.*

BY MANNING K. EYRE.

(Continned from page 138.)

It is evident that there is a limit to the amount of treatment to which a fibre can be subjected, since the filament of the lamp must be a given resistance for a certain candle-power, voltage, and efficiency. In practice the amount of treatment reduces the resistance considerably. Knowing the resistance required in the finished filament, it is only necessary to treat until this resistance has been attained. By the side of the ammeter in Fig. 2 are shown the mercury gauges for indicating the pressure in the treating jar. It was long ago found that to treat under atmospheric pressure did not give satisfactory results, the operation being performed too quickly, and the deposit consequently rough and soft; a pump is therefore connected with the jar to exhaust it. When the gauges show sufficient vacuum the carbon vapour is admitted. The deposit under these circumstances is much more uniform and hard. The time required to treat each set of filaments is for heavy carbons as much as 50 to 60 seconds, and less for the lower candle-powers. In this, as in all the other processes of manufacture, there are numerous uninteresting details requiring the greatest possible care and attention. Were the resistance of carbon constant at all temperatures, the process would be greatly simplified. As the temperature rises, however, the resistance diminishes, which is contrary to the law followed by metals, whose resistance increases with an increased temperature. Therefore, if we are treating two filaments to a given resistance, and treat one at a different temperature from the other, the results will not be the same, though the final resistances are. If the two filaments are now tested at the same voltage, it will be found that they differ in candle-power. This and other difficulties that might be cited can only be overcome by years of experience, skilled labour, and the best quality of apparatus.

The user of lamps can perhaps now understand why, if a number of lamps are run through the factory, say, for 16 c.p. 106 volts, only a portion of these lamps can be furnished of that particular voltage, the balance varying in voltage from about 100 to 102. I have been occasionally asked by central-station people why lamp manufacturers did not endeavour to have all plants installed at three or four voltages. It is evident that if this plan were adopted a large part of the product of the lamp factory would be unsaleable, there being no market for lamps unavoidably manufactured of other than the three or four voltages installed. Of course the immediate effect would be increased cost, and the user would have to pay for the unsaleable product.

The filament being now completed and ready for assembling, we can turn our attention to the glasswork. In Fig. 1, the "inside part" and bulb are shown in various stages of manufacture. The inside part, *b* (Fig. 1), is first a small cylindrical glass tube. Sketch 1, Fig. 3, shows the process known as "flaring," which consists of widening out one end. In the meantime other labour is busy getting the wires ready. Each leading-in wire is composed of two metals, copper and platinum, the former metal being satisfactory for that part of the wire which does not enter the vacuum of the lamp, platinum being necessary for this purpose. Were the wire made entirely of copper, on heating the junction of the copper and glass the difference of expansion of the two substances would cause the glass to crack, resulting in a leaky lamp. Platinum, having very nearly the same coefficient of expansion as glass, obviates this trouble, and, in addition, possesses the advantage of being able to stand the high temperature of the blow-pipe. The copper and platinum are joined by fusion. Only a short length of the latter is necessary.

Sketch 2, Fig. 3, shows the next step in the process of assembling the parts. The two wires are inserted in the "inside part," the blow-pipe flame heating the inner end of the tube, and when the glass is sufficiently soft the operator, with a pair of flat pincers, seals the glass tightly together over the junction of the copper and platinum. This completes the "inside part" (see *b*, Fig. 1). Care must be taken in this operation to prevent cracking the

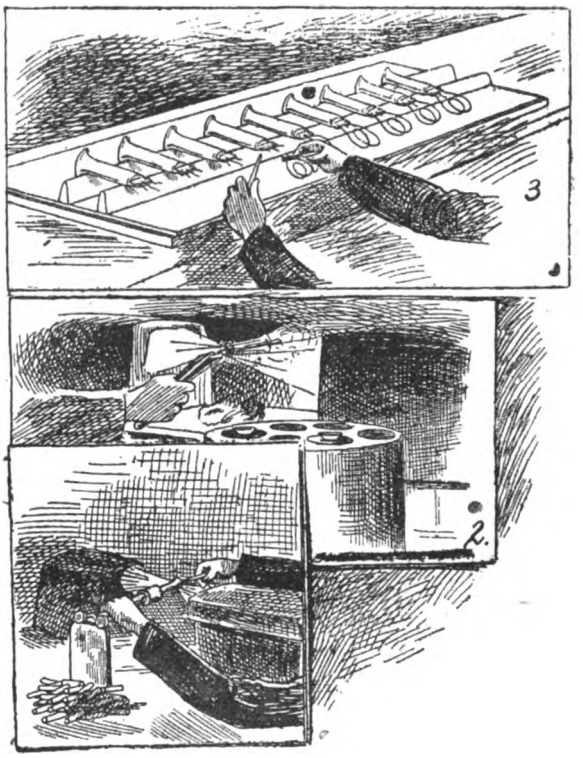

FIG. 3.—Manufacture of Inside Part.—1. Flaring. 2. Sealing in Wires. 3. Clamping.

seal, carelessness in this respect being a prolific source of leaky lamps, which are readily detected in the pump-room, where lamps are exhausted. To prevent this as far as possible, the glass is gradually cooled in an annealer, shown in 2, Fig. 3, after being subjected to the high heat of the blow-pipe. The inside part is now ready to receive the treated filament, the joining of the two together being a comparatively simple operation, commonly called "clamping," shown in 3, Fig. 3. The junction of the filament and the platinum wires may be made by means of a carbon paste, only the two legs of the filament being held in position until they adhere, or a more difficult operation may be employed, using a deposited clamp. The latter is made by heating the junction of the filament and leading-in wires in hydrocarbon gas, being much the same in principle as the treating process. Other methods have been and still are used, as, for instance, the socket joint, where the filament fits into a sleeve of carbon, carbon paste being used to make the junction firm. In another department the bulbs are being prepared for the reception of the inside part and filaments. As bulbs are now very generally moulded, it will not be necessary to describe the operation of blowing the bulbs. These arrive at the factory from the glassworks, as shown in the first sketch, *d* (Fig. 1).

The first step in handling the bulb is known as "tubu-

* The *Electrical World* (New York).

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lating," which consists in attaching to the large end of the bulb a small tube, through which the lamp is later exhausted. This may be accomplished either by heating the rounded end of the bulb in the blow-pipe and at once working the small tube on the softened glass, or by first perforating the grounded end. In the latter operation the worker holds the bulb in one hand and the small exhaust tube in the other, and after heating with the blow-pipe, works them together, the tube fitting over the orifice previously made. The second operation is blowing off a part of the long neck to make the bulb of proper length. This process can be seen in Fig. 4, Sketch 1. The bulb is laid on revolving rollers, *c*, causing the bulb to revolve, while the flame from the pipe heats the neck at the point where it is to be blown off. When sufficiently hot, the bulb is lifted off the rollers, and the neck pulled off by hand, leaving a ragged edge. The operator then blows into the exhaust tube, and the ragged edge is blown out (presenting the same appearance as a soap bubble) until so thin that it can be rubbed off with the finger, leaving a clean, well-defined end (see Fig. 1).

The bulb is now ready for the inside part and filament, which are sent over from the clamp-room, after being carefully inspected. The process of assembling the bulb and inside part is called sealing-in, and can be seen rather crudely indicated in 3, Fig. 4. The blow-pipe flame is,

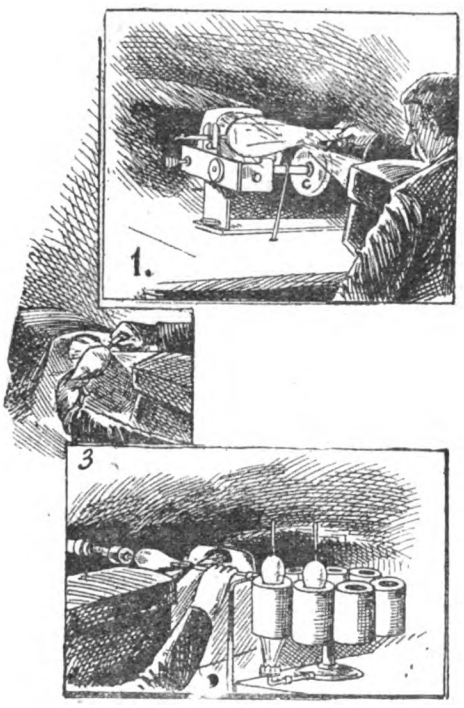

FIG. 4.—Manufacture of Bulb.—Blowing off Bulb.—2. Tabulating.—3. Sealing in

as usual, the means employed. The inside part, with carbon clamped to it, is taken in a holder and inserted in the bulb. The two are then placed in a frame which is slung into the flame. When the glass is softened the frame is swung clear of the flame and the holder inserted in the lower end of the inside part, the operator straightening the inside part and filament until they are in their proper position, as seen in the finished lamp. The bulb is then again lowered into the flame and kept rotating. The glass around the neck of the bulb gradually softens until by its own weight it falls around the flare of the inside part, forming an airtight seal. To prevent sudden cooling, the bulb is then placed in an annealer.

The sealing-in having been completed, the next step is the exhaustion. This is perhaps the most interesting and important process in the manufacture. Too much care cannot be devoted to it, for the quality of the lamps depends on the issue of this operation. It is, of course, understood that a vacuum is necessary to preserve the life of the filament, but perhaps everyone does not know how perfect the vacuum must be, the presence of only a little air oxidising the carbon, burning the filament, and shortening the life of the lamp. It was here that the early lamps failed almost entirely, the vacuum obtained by means of a mechanical air-pump being utterly insufficient. All the pumps now in use are mercury-pumps, generally Geissler or Sprengel pumps. The process of thorough exhaustion is so expensive that many means have been tried to make only a partial exhaustion answer the purpose. Mr. Gilbert S. Ram, A.I E.E., has expressed the whole matter so clearly in his work on the manufacture of the incandescent lamp that I think it would be interesting to the reader to quote him: "It has, at various times, been proposed to fill the bulb with nitrogen gas, and then to only partially exhaust. In this way a residual atmosphere of nitrogen could be left behind, which would be incapable of burning the filament. Another advantage of this method would be that the exhaustion, not requiring to be carried to a very high state, could be done very quickly with a mechanical air-pump. There are, however, several reasons why this method cannot be successfully used. The combustion of the filament with the oxygen in the case of a residual atmosphere of air is not the only action to be considered. In a lamp containing a residual atmosphere of air, nitrogen, or any gas, there are convection currents set up in the gas within the bulb, which consequently becomes very hot. The gas is heated by contact with the white-hot filament, and a continual circulation is kept up from the filament to the bulb, and back again. . . . . One of the most cherished attributes of the incandescent lamp is that it gives off very little heat, and is perfectly safe, and can be handled with impunity when lighted, and may be placed with safety anywhere, even with very inflammable material in close proximity. All these advantages are lost when the vacuum is not perfect. No residual gas can be allowed in the bulb."

(To be continued.)

GOVERNING OF STEAM-ENGINES BY THROTTLING AND BY VARIABLE EXPANSION IN CENTRAL ELECTRIC LIGHT STATIONS.

BY CAPTAIN H. RIALL SANKEY.

Before the Institution of Mechanical Engineers last week a paper by Captain H. Riall Sankey, of Thames Ditton, dealing with the governing of steam-engines by throttling and by variable expansion, was read. Discussing the question from the point of view of engines for electric lighting purposes, the author said:

Electric Light Engines.

In a well-designed central station there will be a number of engines principally of one size and a few smaller engines. The fluctuations of load, although rapid at times, are approximately known beforehand, because they follow with more or less accuracy a previously ascertained load curve. It is therefore possible at all times so to work the engines that the load on those running is approximately their economical load. Under these conditions, expansion governing has no advantages if the engines are working non-condensing; because in this case the economical load is obtained with so high a mean pressure that, except with unusually high boiler pressures, the highest mean pressure that can be obtained gives the best economy. If, however, the engines are condensing, the conditions are considerably changed; because, as already seen, although the economical load is now obtained with a much lower mean pressure—namely, from 28lb. to 32lb. mean pressure according to the boiler pressure—a much greater mean pressure is possible, and it may be expedient to provide for using it. Supposing that the engines are mechanically designed to be able to run continuously with 40lb. mean pressure, and for short periods with 50lb. mean pressure, it is then possible to run them at powers materially greater than their economical load, and this tends to economy, because on a rising load fresh engines can be started later and with more deliberation, and on a falling load superfluous engines can be stopped sooner. In order to work the engines in this manner—that is, with best economy at 28lb. to 32lb. mean pressure and with power to overload—it is obviously necessary to be able to alter the cut-off. Hand gear would in this instance answer the purpose, but automatic expansion gear is undoubtedly preferable.

In order to obtain some idea of the economical gain of expansion governing under such circumstances, the following example has been worked out. The load curve chosen is that for 24 hours at the Kensington electric light station on December 2, 1890, which was first published by Mr. Crompton in his paper read before the Institution of Civil Engineers on April 7, 1891

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(*Proceedings*, vol. cvi., page 7), and which has done duty many times since. It is assumed that each of the principal engines in the station is capable of developing 140 e.h.p. with 40lb. mean pressure in the cylinders, and that there are two smaller engines, each capable of developing 70 e.h.p. with the same mean pressure: these are somewhat larger units than those actually in the station. It is also supposed that the pressure available at the engines is 150lb. absolute per square inch.

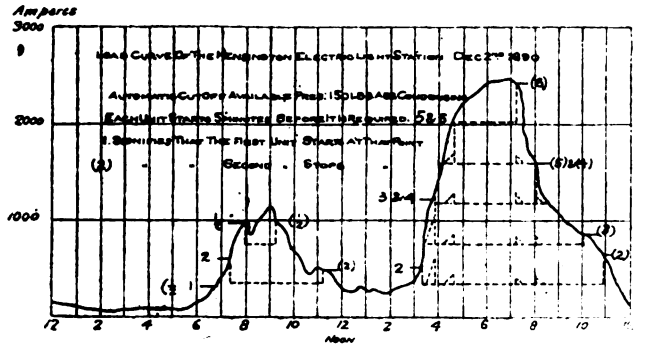

FIG. 1.

Fig. 1 shows the times at which the different engines would be started and stopped when the governing is done by the throttle, the cut-off being arranged for a mean pressure of 34lb. per square inch; and from this, with the help of a constant-expansion steam-consumption straight line, the water required to be evaporated for the engines only can be calculated, and is found to be 110,330lb. for the 24 hours.

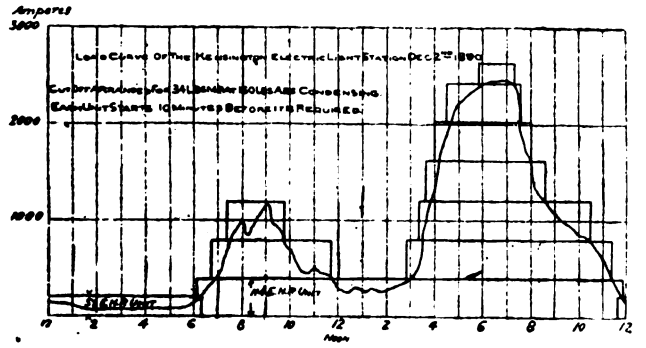

FIG. 2.

Fig. 2 shows the effect on the times of starting and stopping when the engines are governed by the cut-off, and are allowed to be overloaded up to 50lb. mean pressure for half-an-hour, assuming that the dynamos are designed to stand this overload. As before, the total water required in 24 hours can be calculated with the help of the constant-pressure consumption curve, and it works out to 87,240lb.

In the particular instance here chosen it will be seen that at the time of maximum load six units are running with expansion governing as against 6½ with throttling. This points to the fact that expansion governing tends to reduce the number of engines required in an electric light central station; in other words, it can better be afforded to overload engines with expansion governing than engines with throttle governing, for in the former event the economical ill effects of the overload are temporary, while in the latter they are permanent. On the whole, therefore, it can be stated that for large central electric light stations, when working non-condensing, throttling is as good as expansion governing; but when condensing, governing by the cut-off has a superiority.

An electric light station containing only one engine will evidently be worked most economically by altering the cut-off, if the engine is condensing. If the engine is non-condensing, the case is not so clear. A great deal depends on the boiler pressure that can be obtained, and it will be observed that the power of overloading the engine is not of much advantage, because in all probability the time of overload would last too long to be permissible, unless there were a peak in the load curve, in which case, of course, expansion gear would be of use. Thus one of the factors determining the relative merits of the two methods of governing, as applied to this particular kind of work, is the shape of the load curve; but as it is impossible to know beforehand what the shape will be, it is best in practice to arrange the engine with expansion gear, because this will meet all cases, whereas throttle gear will not. In electric light stations of medium magnitude, containing, say, three or four engines, throttle governing will give as good results as expansion governing if working non-condensing; if condensing, expansion governing will be best.

Dynamo Engines for Transmission of Power.

Many different cases occur, depending on the number of motors and on the kind of work to be done; and the difference will be expressed by the shape of the load curve. When there are many small motors which are not frequently started and stopped, changes in load will take place gradually; the load curve will be fairly regular, and in shape not unlike that for electric light stations: evidently, then, the same remarks apply.

A somewhat unusual case and difficult to deal with is that of a single motor driven by a single dynamo, the latter in its turn driven by a single engine. The first difficulty is met with on starting the motor, especially if it has to start with even a small load on it. The torque, or turning moment, required for starting is great, and if the engine is governed by the throttle, the maximum torque which the engine can give out is reached sooner than if the engine is governed by the cut-off, because the latter allows of momentary excessive overload. The second difficulty occurs whilst the machinery is running, should the load fluctuate considerably in the neighbourhood of the full load. If the engine is governed by the throttle, directly the full load is overstepped the speed of the engine must drop. The available horse-power will thus be diminished, and if the load remains only for a short time above the full load, it must inevitably pull up the engine, or, rather, it would do so were it not that the fuses in the circuit would blow, owing to the abnormal increase in the current due to the reduction of counter E.M.F. in the motor. If, on the other hand, the engine is governed by the cut-off, the overload on the motor will be met by an overload on the engine, and the difficulty will disappear. This is evidently a case where expansion governing is far preferable to throttling, and, in fact, may be said to be necessary: although throttle governing could be made to answer, by fixing the cut-off late enough, but then the economy of working would be greatly reduced.

Electric Tramways and Railways.

The most important case, however, is that of electric tramways and railways. A glance at the typical load curves illustrated in Figs. 3, 4, and 5 will show that the machinery cannot be worked like that of an electric light station; that, in fact, all the engines, except the spare ones standing in reserve, must be kept running, and that they are alternately fully loaded and lightly loaded at short intervals of time. The power of being able to overload the engines for a short time, as can be done with expansion governing, is here of the utmost importance, especially from the economical point of view; and there is the incidental advantage, as previously explained, that expansion gear responds more readily to sudden changes of load. This being so important a case, it may be well to illustrate it by a numerical example. Figs. 3, 4, and 5 are typical load curves for 10 minutes on an electric railway; and it will be noticed that in each of the three figures a peak of the same height is shown at A, so that the same number of engines have to be worked in each instance. It is proposed to calculate the water required to be evaporated for the engines during each 10 minutes under the following five different conditions: (1) the engines are governed by the throttle-valve with the cut-off arranged for 35lb. mean pressure, when the full available pressure is used; (2) the engines are governed by the throttle-valve with the cut-off arranged for 45lb. mean pressure, when the full available pressure is used; (3) the engines are governed by the throttle-valve with the cut-off arranged for 50lb. mean pressure, when the full available pressure is used; (4) the engines are governed by the cut-off; (5) the engines are governed by the cut-off from 20lb. mean pressure upwards, and by the throttle-valve from the same mean pressure downwards.

In Fig. 3 there are three peaks of nearly the same height as A, and the engines are comparatively well loaded during the whole 10 minutes. In Fig. 4 the other peaks are of medium height, and this figure represents a medium load on the engines. Lastly, Fig. 5 denotes only a light load on the engines. It will be supposed that each engine is capable of developing 980 i.h.p. at 35lb. mean pressure, 1,260 i.h.p. at 45lb., and 1,400 i.h.p. at 50lb. mean pressure; further, that the engines are condensing, and that the full available pressure is 150lb. absolute. It will then be possible to use the consumption curve given in Fig. 6.

In the first case, throttle governing with the cut-off arranged for a maximum of 35lb. mean pressure, it is necessary, as shown in Fig. 3, to keep six engines running; and since they are working with constant cut-off, the consumption at all loads will be represented by a straight line, and therefore the total actual consumption will be the same as if the engines were working under a constant load equal to the average load.* For the 10 minutes under consideration the average load is found to be 3,116 i.h.p.; hence the average mean pressure is 35 × 3,116

* This result follows at once from the Willans straight-line law; and, moreover, the author obtained an experimental proof, as mentioned in his remarks upon Dr. Edward Hopkinson's paper on the City and South London Electric Railway (*Proceedings* Inst. C.E., 1893, vol. cxii., p. 263).

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TABLE I.—Electric Tramways and Railways.—*Water Consumption During 10 Minutes.*

—	Fig. 3.				Fig. 4.				Fig. 5.				Unit sets of engines and dynamos required.
Maximum E.H.P. in each case 4,634.	Average E.H.P., 2,117.				Average E H.P., 1,527.				Average E H.P., 750.				
Conditions of governing.	I.H.P.		Water consumption.		I.H.P.		Water consumption.		I.H.P.		Water consumption.		
	Maximum.	Average.	Total.	Increase *	Maximum.	Average.	Total.	Increase *	Maximum.	Average.	Total.	Increase *	
	I.H.P.	I.H.P.	Lbs.	p.c.	I.H.P.	I.H.P.	Lbs.	p.c.	I.H.P.	I.H.P.	Lbs.	p.c.	Units.
Cut-off fixed for 35lb. mean pressure	5,633	3,116	8,740	21·6	5,633	2,526	7,490	27·8	5.633	1,749	5,830	38·2	6
,, ,, ,, 45lb. ,, ,,	5,466	2,950	8,590	19·6	5,466	2,359	7,150	22·0	5 466	1,582	5,300	25·8	5
,, ,, ,, 50lb. ,, ,,	5,300	2,783	8,250	14·8	5,300	2,193	6,730	14 8	5,300	1,416	4,750	12·7	4
Variable cut-off	5,300	2,783	7,220	0·5	5,300	2,193	5.895	0 6	5,300	1,416	4,560	8·2	4
Variable and fixed cut-off..... ...	5,300	2,783	7,185	0·0	5,300	2,193	5,860	0 0	5,300	1,416	4,215	0·0	4

* The figures in these columns are the percentage increase in water consumption compared with the fifth arrangement.

$\div(6\times980)=18{\cdot}55$lb. per square inch. Referring to Fig. 6, it will be seen that the water consumption of the standard-consumption engine at this mean pressure is 312lb. per hour; hence the total consumption for the 10 minutes is $(311\div6)\times6\times980\div35=8{,}740$lb. The water consumption for Figs. 4 and 5 can be found in exactly the same way, and the result is given in Table I.

In the fourth case—expansion governing—the consumption for the short-period heavy load will evidently be the same as in the third case, but owing to the cut-off being altered, considerable economy is obtained at the lighter loads at which the engines do most of their work. The total water cannot in this case be obtained from the average mean pressure, because the consumption line is no longer a straight line, but has to be

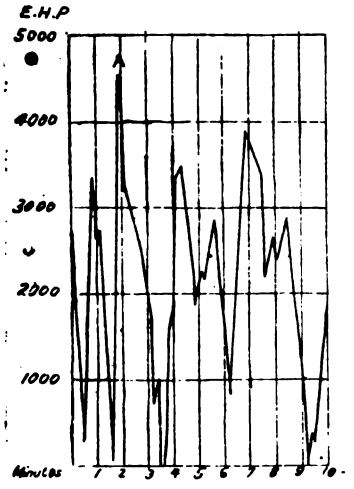

Fig. 3.

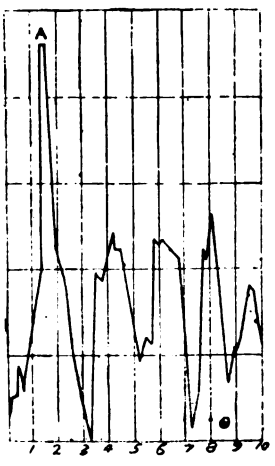

Fig. 4.

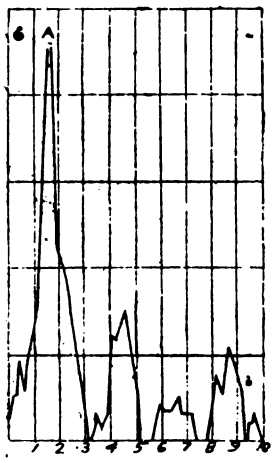

Fig. 5.

In the second case—throttle governing with the cut-off arranged for 45lb. mean pressure—it is found that this increase in the available power of each engine allows of stopping one engine, keeping only five running. The consumption of each engine is now represented by the Willans line W_2, and is greater than in the first case; nevertheless, the total consumption is less than in the first case, as shown in Table I.

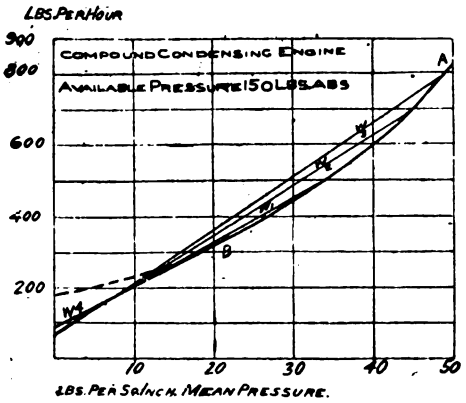

Fig. 6.

In the third case—throttle governing with the cut-off arranged for a maximum of 50lb. mean pressure—only four engines are required, because they can now develop for short periods a sufficient power; but as the cut-off must be later the consumption at all loads will be greater, as shown by the Willans line marked W_3, in Fig. 6. The average indicated horse-power, however, is smaller, because the losses in the dynamo and engine of the fifth and six set are saved. The average thus becomes 2,783 i.h.p., and the total water consumption for the 10 minutes comes out to 8,250lb. for Fig. 3.

ascertained from the consumption for each element of the load. The result is 7,220lb. for the 10 minutes for Fig. 3, as given in Table I.

In the fifth case — combined expansion governing and throttling—the consumption is given by the constant-pressure water-consumption curve down to 20lb. mean pressure, and for lighter loads by the Willans line marked W_4 in Fig. 6. The calculations are similar to those in the previous cases, and the results are given in Table I.

A comparison of all the results obtained, Table I., shows that the fifth arrangement is the best for all three typical load curves. On the mere question of economy of water evaporated it will be noticed that there is perhaps not so much difference between the first three arrangements as might be expected. The third arrangement has, however, the great advantage that only four engines are required. The advantages of expansion governing are striking: a considerable saving in feed water is effected, and two engines less are needed than in the first arrangement. In fact, this is just the case where expansion governing might almost be said to be a necessity.

LORD KELVIN AT WOLVERHAMPTON.

At the luncheon which followed the opening of the Wolverhampton central station, which we briefly described last week, Lord Kelvin delivered an address. In the course of his remarks he said that Wolverhampton had gained by being patient in the matter, and waiting for the best scheme, and the works he had just inaugurated had a particular interest for electricians, for he had always advocated high pressure when distant work had to be done. The works there were practically the third of their kind adopted in the country, for the system was first introduced in the Chelsea system, and then carried out by the Electric Construction Company in lighting the town and University of Oxford, the success of which work

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was due to Mr. Thomas Parker. He hoped the Wolverhampton scheme would be a similar success. The Corporation had done well in taking the course they had, and were pioneers of progress in adopting the system he had mentioned for Wolverhampton. The method which had been adopted by the Wolverhampton Corporation had not had a very widely extended trial, but the trial had been sufficiently severe to prove it to be the best adapted for the purpose required, and he thought that the lighting bill, and machinery bill, and labour bill of the undertaking, and all other expenses, would compare favourably with the cost of similar undertakings in any other town in the United Kingdom. The direct-current transformer, which really originated with Mr. Thomas Parker, had been adopted, and it was perfectly well known as associated in a fundamental manner with the idea of the conveyance of electricity over long distances. Electricians did not seem to appreciate the possibility of obtaining dynamos for a voltage of as high as 20,000. A great many of them, indeed, said that they could not make a 20,000-volt direct-current dynamo, but he would guarantee that certain electrical engineers only wished that they could get an order for the manufacture of such a dynamo. The fact that a 2,000-volt dynamo for direct current was the highest that had been made was not a reason for believing that it could not be exceeded. He was quite sure, however, that it could be, if only by the method of placing 10 2,000-volt dynamos in series. In this way it would be perfectly easy to obtain a voltage of 20,000, even in the absence of dynamos capable of producing a voltage of more than 2,000. That method had also this advantage—that it very greatly reduced the possibility of a breakdown. They had present at that gathering in the persons of the contractors guarantees for the success of the undertaking. Messrs. Parker, Blackburn, and Callender were three great successful electrical engineers. He had been to the Town Hall and had seen the transforming system (which had worked so well at Oxford) in operation, and also a method of regulating the pressure which was almost entirely novel, having been only partially realised in Oxford. In Oxford, however, the current never exceeded 1,000 volts, whereas in Wolverhampton it could always be maintained at 2,000. The general principle of regulating the pressure which was adopted there was the work of the Electric Construction Company. The pressure was regulated at the Town Hall, where there were four transformers, and where the high-pressure current received from the generating station was reduced in voltage sufficiently for the purposes of consumers. Electricians would look with intense interest to the working result of the system, and it had already worked sufficiently to justify the boldness and the wisdom of the Corporation in adopting the system.

THE PROJECTED ELECTRIC TRAMWAY AT ACTON.

The Parliamentary Committee of the London County Council reported as follows to the latter on Tuesday concerning the provisional order of the London United Tramways Company, to which we referred last week:

This order is to authorise the construction of doublings and passing-places in King-street, Hammersmith, and of a short single line to connect the existing tramways in King-street and Beadon-road, and to construct other lines outside the county boundary. There is also provision in Clauses 10 to 22 for the use of electric or other mechanical powers, subject only under Clause 11 to the consent of the Board of Trade during any period not exceeding seven years, and Clause 20 expressly sanctions the use of overhead wires, and the placing of posts and brackets in the streets as may be necessary and proper for working the tramways by electric or other mechanical power. The Council on January 29 refused its consent to a proposal of the company to adopt a system of electric traction by means of overhead wires, and the Highways Committee is of opinion that this clause should be struck out of the Bill. Clause 7 empowers the company, with the consent of the Board of Trade, to vary the construction of lines authorised or laid, and Clause 9 sanctions the construction with the approval of the Hammersmith Vestry, of any passing-place which may be found desirable. The consent of the Council also should be necessary in these clauses, and in Clause 11 above referred to. The Highways Committee is of opinion that the Council may be advised to consent to the order being proceeded with upon the promoters giving an undertaking to insert a similar clause to Section 23 of the West Metropolitan Tramways Act, 1889, and also for providing for all new works under the order, and all renewals or reconstruction of existing lines to be carried out to the satisfaction of the Council within two years from the confirmation of the order, and that the time of purchase of all the tramways of the company within the county of London shall be 1909 instead of 1903; and if the works requisite for completing the lines and putting them in good working order to the satisfaction of the Council be not carried out within the two years above specified, the provisions of Section 23 of the Act of 1889 to apply to all the tramways of the company, including those to be authorised by the order; and that the order shall be amended by the insertion of such of the Council's standard clauses as the Council may require, the elimination of Clause 20, the amendment of Clauses 7 and 9 by the insertion of words making Council's consent a necessary preliminary to any works under those clauses and that the order shall be further amended as the Council may require. We recommend that the Council do consent to the order being proceeded with, subject to the above-named conditions.

NEXT WEEK'S NEWS TO-DAY.

The Welsh Land Commission met yesterday and took evidence on the subject of light railways.

The shareholders of the Waterloo and City Railway Company held their second half-yearly meeting yesterday, when the report was adopted. The report seemed satisfactory, and everybody seemed satisfied with it.

Mr. Bryce had given notice that he would, yesterday, ask for leave in the House of Commons to introduce a Bill to facilitate the construction of light railways in Great Britain. Yesterday in the House, on the motion of the Chancellor of the Exchequer, it was resolved that to-day the introduction of Bills should have precedence of the orders of the day.

The officers of the District Railway have been puzzled of late on account of the repeated forcing of the locks of the electric reading-lamps and the abstraction of the pennies. A sharp watch was kept, and an inspector caught Frank Trew, a boy of 14, with whom was a boy of 13 named Flint, forcing the lock with a penknife. Both boys were arrested, and charged at Westminster yesterday. The magistrate ordered Trew to pay the damage and 1s. fine, or be imprisoned for seven days. The younger prisoner would be remanded to the workhouse for a week.

Mr. Bryce, replying yesterday in the House of Commons to questions by Mr. Howard and Mr. Rowlands as to the recent explosions in Cannon-street, Southwark Bridge, and elsewhere, said the electric lighting regulations provided that all street boxes shall be efficiently protected against any contact with gas or water pipes, and the Board was earnestly pressing upon electric lighting companies the necessity for compliance with these regulations. It was desirable that gas companies also should take the best steps to remedy defects in their plant, and he was now calling their attention to the matter.

THE CANNON-STREET EXPLOSION.

The report of Major P. Cardew to the Board of Trade has been issued concerning the accident which occurred in the City on November 10, 1894, when a horse was killed and some persons suffered injury and received electric shock. Major Cardew deals at some length with the causes of the accident, and makes several recommendations, including the adoption of a system of natural or forced draught. Pressure on our space prevents publication of the report in the present issue. It may, however, be mentioned that the inspector states that the causes of the explosion were the breaking down of the insulation of a high-pressure main in the street box at the corner of Budge-row, leading to the formation of a powerful electric arc between the outer conductor of this main and the end of the iron pipe forming a conduit for the mains under Budge-row, which projected into this street box, and the consequent charging of this pipe to a dangerous extent, and the presence of gas in the electric light company's pipes and street boxes to an amount which formed a highly explosive mixture in the street box at Walbrook, where the more serious explosion occurred, the gas being fired by the electric arc.

Proposed International Exhibition.—Mr. G. Hayter Chubb suggests that a great international exhibition should be held in London in 1901.

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EXPLOSIONS AND UNDERGROUND MAINS.

It was only a few weeks ago, as will be seen from our issue of January 11, that we discussed the question of mixtures of coal gas and air being ignited in connection with underground mains laid in conduits or pipes. Since then our columns have contained statements of the results emanating from the practical experience of, among others, gentlemen engaged in the most important electricity works in this country. A perusal of our present issue, and of those of the 25th ult. and 1st inst., is sufficiently convincing on this point. It shows four remarkable facts. First, that very little, if any, trouble has arisen through the accumulation of coal gas in conduits or boxes so as to form an explosive mixture with air and eventually result in an explosion. It demonstrates, secondly, that the consensus of opinion is that explosions can be prevented by the adoption of efficient means of ventilating the underground systems. Thirdly, that the use of armoured concentric cables laid direct in the ground renders practically unnecessary any consideration of the question of explosions, no such trouble being experienced in connection with this system. It demonstrates, fourthly, that the so-called danger of electrolytic action is a bogie which may be entirely dismissed from consideration at the present time.

Taking the four points *seriatim*, it is gratifying, on the one hand, to be able to record that in the majority of cases coal gas has not proved to be a bugbear in regard to central-station working; but at the same time it appears unfortunately to have recently come forward as a disturbing factor, and this danger has still to be dealt with—and obviated. Even during the past fortnight explosions have occurred in London, Dover, Rochester, and Eastbourne, as mentioned in another part of the present issue. In three of these cases it has been shown that the ignition of explosive mixtures of gas and air has not been brought about through the electric supply systems, although occurring in connection with the underground work; whilst in the fourth instance the explosion is attributed to sparking. Moreover, Major P. Cardew, whose report on the Euston-road explosions is given in another column, concludes that they were due to the firing of a mixture of coal gas and air by an electric spark, and he emphasises the importance of overcoming sparking and of providing efficient means of ventilation. Of course these constantly occurring explosions are alarming, and just in the same way as they can be prevented, so must they be avoided. As to the second point, there seems to be not the slightest doubt that this important question of preventing explosions has not been sufficiently considered by supply companies and corporations. With a properly designed underground system the possibility of the ignition of an explosive mixture of coal gas and air should never be present. It all depends upon what it is intended to use—whether ventilating pipes, grids, or the forcing of dry air under pressure throughout the whole of the system of conduits or pipes, or placing sandbags in the boxes and chambers. What

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may be suitable for one town may be unsuitable in another. The third point scarcely needs any consideration. The boxes are so small that no one at the present day would dream of explosions in connection with them. As to the fourth, that has already been answered—the so-called difficulty is non-existent.

It is quite obvious that the explosions which have occurred never ought to have happened. It is also evident that if underground conduit and pipe systems had been originally designed with a view to meet possible contingencies in the future, such explosions would not have taken place, and they should not do so now. Someone is to blame for this neglect, and the difficulty is to locate the responsibility. Electric lighting companies and corporations were perfectly aware before laying electric light mains or cables of the saturation of the subsoil with coal gas. It was not a new thing to them, and their duty was to so design their systems that either sparking should not occur or that gas, at all events, in sufficient quantity so as to form an explosive mixture with air, should not reach any part of the system where sparking might occur. But as the condition of affairs in the majority of cases is that no such provision has been made in the laying of underground systems, the best must be made of existing circumstances. Ventilation in some form or other is absolutely essential, and some efficient system must be introduced to overcome the present difficulty, whilst the connections in the boxes must be so made that sparking is rendered impossible. The subject must be thoroughly thrashed out, and we would suggest that the Council of the Institution of Electrical Engineers should allow two or three evenings for the matter to be properly discussed.

TROP DE ZELE.

The ambitions—and efforts to attain them—which have been manifested continuously by the London County Council in the direction of municipal undertakings are of a most far-reaching and inclusive order, and the limits to operations or matters deemed to be of public interest are—if even decided at all—certainly put so wide as to be almost out of sight. With respect to such matters as the supply of gas, electric light, and water, or even the ownership, if not the operation, of tramway lines and other methods of rapid transit, opinion is, as we have frequently had occasion to point out, fairly unanimous in approving of these as proper objects for municipal undertakings, whether in London or elsewhere; but when we come to other matters—the proper development, for instance, of a telephone exchange system in any urban district—the question is not so readily decided in the affirmative.

It is confessedly difficult to draw any exact line between matters rightly concerning local authorities and those which should remain outside their range of action, and even the principles which might lead to a decision are by no means clearly enunciated. Is, for instance, a local authority to take up only such enterprises as it can profitably conduct, or must the broad question of public benefit alone decide upon municipal undertakings? Then comes the question as to what matters *are* actually of general public benefit. Artificial light and water supply are obviously needed by all: tramways and other means of rapid transit are required by the majority, and perhaps should be included. Can the same be said of telephones?

The London County Council (and many other municipal bodies, too) think that the urban telephone systems ought rightly to be in the hands of the municipalities, and this position was emphasised by the deputation from the Council which waited upon the Postmaster-General a few days ago with reference to the subject. We cannot help thinking that Mr. Arnold Morley took the proper line in this matter, and showed to the deputation that, whilst being far from hostile to municipal enterprise, the Government could hold out no great hope to local authorities of municipal telephone systems coming into existence for many long years, if, indeed, at all.

We have already had occasion to point out that the purchase and erection by the Government of trunk mains for telephone use over the country must prove to be the first step in the direction of eventual State control over the entire enterprise, just as with the telegraphs: and it is a very big first step, being practically halfway to the desired end. But at present, and whilst the National Telephone Company hold their license, there seems no prospect of successful competition on the part of any local authority in establishing a telephone exchange system. Technical considerations—the want of uniformity in systems used in different towns, etc., or the mere question of metallic returns alone—must prove formidable drawbacks to intercommunication between towns where one is in the hands of the National Company and the other operated by the local authority, even supposing that the former would be willing to accept messages brought over the Government trunk mains from outside their own domain. We do not attempt here to fully discuss the question of urban exchange work, for obviously this might be as advantageously carried on by the local authority as by the National Company, if the ratepayers consider it wisdom to spend large sums in buying or erecting a complete urban system which cannot fairly be of use to one-third or less of the inhabitants. The proportion in London alone is not more than 1 per cent. of the total number of householders, if, indeed, as much; and cheaper rates, coupled with better service, would not increase the list of subscribers so materially as to justify the enterprise becoming a municipal undertaking.

From both aspects of the case, therefore, we consider that the County Council failed to make out its case in this matter, either as regards the question of urban or inter-urban communication; and all that can be said is that it has shown "too much zeal"—has been premature and hasty in attempting to carry more on its shoulders than is right or advisable. Questions like that of telephonic communication require handling by the statesman accustomed to national affairs, rather than by the man of smaller views who perhaps does excellent work in parochial affairs.

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CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC BRAKE COUPLINGS.

SIR,—If Mr. Frank B. Lea will tell me in your next what he does not understand, I will try and explain the queries he does not understand. As to the connections he speaks of with the car axles, this I fail to understand. In air and vacuum systems there is a rubber pipe to give flexibility when turning round curves. This pipe is between the carriages, and Mr. Lea can see it if he goes to any of the railway termini. I meant the wires which convey the current to the magnet to apply the brake, like the Timmis-Forbes brake, for instance, which was tried about five years ago. Now, in electricity there would be wires running through the train, and perhaps I ought to have said joints—by this I mean where the wires connect together so that they can be connected or disconnected. In railway language, the rubber pipes are known as couplings. I don't know what other name to call them. What I meant by reliable was, could they be connected and disconnected easily, and when once connected would they come apart, and would there be excessive leakage; and if they did come apart, would it injure the wires or joints?

There is, of course, only one company of the name I spoke of. I don't see how there could be two, or else the Electric Traction Company would get an injunction against the new one to prevent it from using its name. The one I meant was in New Broad-street, but it has been wound up, also the General Electric Power and Traction Company, a reconstruction of the old one, has shared the same fate.

If Mr. Lea does not understand my queries, would he mind giving me his address, and he can have mine, as if I sent him a sketch he might be able to know what I mean. Perhaps he will tell me also where I can see a sketch of the jack-spring coupling he mentions.—Yours, etc.,

London, February 5, 1894. A. M. BUSHELL.

OBITUARY.

GEORGE E. PREECE.

We regret to announce the death of George E. Preece, who was born at Carnarvon in 1838, and died at Colwyn Bay on the 2nd inst., having nearly completed his fifty-seventh year. The deceased, who was the brother of Mr. W. H Preece, F.R.S., entered the service of the Electric Telegraph Company in 1854, and from 1856 to 1861 was attached to the repairing ship "Monarch." In the latter year he went to Malta in charge of the Mediterranean cables, which formed the commencing link of the present Eastern Telegraph Company's system. He was also employed in laying the cable from Florida to Havana in 1867-8. In 1869 George E. Preece was connected with the laying of the Persian Gulf cable, and was wrecked in the P. and O. steamer "Carnatic" in the Red Sea in September of that year. Subsequently he was employed upon the construction of the French, Atlantic, British-Indian, and Falmouth and Gibraltar cables; and also was in charge of the manufacture and submersion of the Jersey and Guernsey Company's cables. He joined the Post Office Telegraph Department at the transfer of the telegraphs to the State in 1870, but retired in 1878. He was secretary to the Society of Telegraph Engineers from 1872 to 1876, and his paper on "Underground Work," read before the society in 1873, was highly appreciated by the profession. In 1884 he joined the firm of Messrs. Walter T. Glover and Co., and died in the company's service. The deceased had been in failing health for some time, and was, in consequence, incapacitated from attending to his duties; but all through his illness he was ever ready and willing to give such information as he could to his fellow-officers. This was always valuable, in consequence of his long experience, especially in connection with the company's electrical testing department. The deceased, who was a frequent contributor to the technical journals, especially the *Electrical Review* and the *Mechanical World*, as well as to the Society of Telegraph Engineers, was interred at Manchester on Wednesday.

REVIEWS.

Lockwood's Builder's, Architect's, Contractor's, and Engineer's Price-Book for 1895. Edited by FRANCIS T. W. MILLER, A.R.I.B.A. London: Crosby Lockwood and Son. Price 4s.

To the electrical engineer there is little of interest in this price-book. There are some 30 pages devoted to electric lighting plant and accessories—and that is all. Consulting electrical engineers who are their own architects will, however, find much information of value, although the book, giving as it does the latest prices of materials and labour in trades connected with building, mostly appeals to builders, engineers, and contractors. A copy of the new Act relating to buildings in the Metropolis is given as a supplement.

THE MADAGASCAR CABLE.

In referring to the recent outburst of Anglophobia in the French Chamber, the Paris correspondent of the *Times* says: "When some months ago there was a talk of laying a cable to Madagascar, one of the leading English firms offered, under the most absolute conditions of security, to lay the cable before the date fixed for the departure of the expedition. The offer was refused, and the contract was given to the Construction Electrique de France at a much higher price—300,000f., I believe—and it will most likely not be laid in time. Such is the present strange and dangerous state of mind of Frenchmen."

In reference to the same subject, the chairman of the Eastern Telegraph Company is reported as informing his shareholders that proposals had been made by the company to the French Government to connect Madagascar with the present cables at Mozambique, but that the French Government did not avail themselves of this offer. Sir John Pender also points out that the company had always ships about with cable on board of them, and that if any hitch occurred in the work he should not be astonished if in this case, as in others, the company should eventually lay the Madagascar cable.

It is, however, possible that the coyness of the French Government may arise from the knowledge that the cables both north and south of Mozambique have been in a very unsatisfactory state for the last few months. According to official reports, we find that some of these cables between Durban and Aden have suffered interruptions amounting to a lump total of 148 days in a period of 118 days. It is true that these interruptions were concurrent, and that the cable which was interrupted for the longest time was duplicated; but such a state of affairs is in no way calculated to inspire confidence in the French Government, who, in any case, are doing all they can to protect and foster the manufacture of telegraph cables in their own country.

LIGHT RAILWAYS.

In our last issue we editorially summarised the report of the Committee of Conference on Light Railways. We now give below the memorandum signed by Messrs. W. J. Carruthers-Wain and Stephen Sellon and Sir Albert K. Rollit, M.P.

MEMORANDUM.

We regret we are unable to sign the report, and beg to give our views upon the questions submitted to the conference.

(1) The committee considered closely the present law as well as the Board of Trade and local regulations concerning tramways of the first magnitude, such evidence having occupied the attention of your committee for two sittings, and has been the subject of constant reference throughout their deliberations.

(2) To relieve the congested districts, to afford communication between urban and suburban districts, and also to provide facilities for the transit of passengers and goods from and to the great cities, large extensions of the existing tramway systems would be most advantageous, and naturally would not necessitate the purchase of valuable land, either for terminal stations or for carrying the lines through towns, and would, in addition, get rid of terminal charges and the construction of the most costly works of a railway—viz., tunnels, cuttings, embankments, viaducts or bridges, stations, and expensive

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signalling and interlocking apparatus. In many cases such lines could be made at the sides of the roads, or on the waste land at the sides, thus avoiding any extensive interference with the public highways.

(3) It is to be regretted that the railway companies do not appear to have seen their way to have made any serious attempt to construct light railways as feeder lines. Had they so desired, special powers might have been obtained for the purpose without regard to the Light Railways Facilities Act, 1864, especially after the adoption by the Standing Orders Committee of the word "tramroad," a distinction made to enable light railways to be constructed under the Tramways Act with no statutory regulations as regards speed working unless they are laid on the public highways, in which case modified regulations under the Tramways Act apply. Parliamentary sanction has been given for the construction of several miles of this class of line, and they would have been made if the projectors had been possessed of the same advantages which railway companies have when promoting extensions of their own systems.

It is not generally understood that tramroads are entitled to the benefits of the Railway and Canal Traffic Acts, and can therefore insist on having working agreements with the neighbouring railways as if the tramroads were railways.

We consider that the lack of progress in the construction of tramroads or light railways as feeders has been due to the want of more generous treatment by railway companies, and as an example we refer to the Southwold case. It appears to us that such treatment would not have been detrimental to the interests of the railway companies.

(4) We think that the statement in the report as to the lack of progress, and the impediments to the construction and restrictions on working, does not sufficiently represent the actual facts, as it is well known that obstacles to the construction of tramroads and tramways have been unnecessarily interposed by the local authorities and the Board of Trade, notwithstanding that either of these bodies have the power to modify or relax many of their requirements.

We recommend that the Board of Trade should have full power to modify or dispense with any of the existing restrictions on the construction and working of tramways.

The absence of progress in this country is best illustrated by showing the mileage of secondary railways alone, not including tramways open for traffic in the following countries, from official information given to the committee :

	Miles.
France, 1893	2,250
Hungary, 1892	2,300
Germany, 1892	1,620
Italy, 1890	1,250
Belgium, 1893	770
Netherlands, 1894	160

(5) With regard to the expenses of promotion, we recommend that where county councils are themselves promoters of light railways, tramroads, or tramways no deposit should be necessary, and that where independent promoters seek to obtain similar powers, no deposit should be payable until the lines have been authorised and the work of construction about to be commenced, in which case a deposit should be made to the local authority; such deposit being returnable with interest *pro rata* on the completion of each section of line as may be agreed.

With a view to reducing the cost of promotion, we recommend that, instead of the present mode of procedure, it is desirable that Parliament should authorise the Board of Trade to sanction the construction of light railways, tramroads, or tramways which are approved by the county council concerned, and in cases where several county councils are interested the Board of Trade, after holding a local enquiry, should have power to overrule the objections of the minority.

(6) As under the present standing orders affecting tramroads and tramways one frontager has prevented Bills being considered on their merits, we recommend in all cases of opposition by frontagers that claims both as to opposition and compensation should not prevent a Bill or order being considered on its merits, and if the proposed line is shown to be of public utility, the opposition of such frontager or frontagers should be overruled.

(7) The committee considered the question of acquiring land by compulsory powers, and we recommend that the principle adopted by the Local Government Act of 1894, in regard to the compulsory acquisition of lands for certain purposes, should be extended so as to enable local authorities to purchase lands necessary for proposed lines.

We consider that it is contrary to the public interest to grant without the closest enquiry any powers for the compulsory acquisition of land by any railway, tramroad, or tramway company which is desirous of obtaining powers for the conveyance of goods and not of passengers.

(8) The committee have had abundant evidence to convince them that, except in isolated cases, it would be impossible, under existing conditions, to obtain from the public the financial support necessary to enable light railways, tramroads, or tramways to be economically constructed, and we feel, therefore, that having regard to the terms of the reference and to the speech of the President of the Board of Trade at the recent conference, it is our duty to state our opinion that, following the precedents in Belgium and other countries, that the county councils and other local authorities should be empowered to subscribe or guarantee capital, or interest on capital, for this purpose.

GAS EXPLOSIONS.

Southwark Bridge

A somewhat serious explosion took place early on Friday afternoon on Southwark Bridge, whereby five persons were injured. It appears that the explosion occurred in the four boxes near the centre of Southwark Bridge, on the east side. The force of the explosion blew up the pavement and wrecked the framework of the covers on the boxes, which were shot some distance into the air, and on the south-west end of the bridge a large hole was made in the pavement, close to a gully which is contiguous to some junction-boxes.

An enquiry into the cause of the explosion was held on Monday at the Guildhall by Major Cardew, on behalf of the Board of Trade. Mr. H. Homewood Crawford (City solicitor) appeared for the Corporation, the trustees of the Bridge House Estates, who own Southwark Bridge, and he also represented Lieutenant-Colonel H. Smith (commissioner of City Police). The City of London Electric Lighting Company, Limited, was represented by Mr. F. Bailey (chief engineer), and the South Metropolitan Gas Company, Limited, by Mr. Frank Livesey (chief engineer).

Police-Constable Sawyer said that on the day of the accident he was on the west side of Southwark Bridge, going north, when he heard an explosion behind him. As he was turning round another occurred. He saw three clouds of smoke rising and a man blown into the air several feet.

Miss Florence Heath, residing at South Hampstead, stated that when walking about half-way across the bridge from the City she saw a cloud of smoke on the west side at the south end, and heard a loud report. This was followed by another explosion just in front of her, with smoke, accompanied by the displacement of flagstones. When turning round she heard another explosion.

Several other witnesses gave corroborative evidence.

Police-Inspector Eve said that shortly after 2 p.m. on the day in question, he was on the bridge with officials of the electric lighting company. They went to the iron box lid at the south-east corner and lifted it. There was a strong smell of gas from the box, which contained a gas-meter. They then went to a similar box with a meter on the west side, where there was also a strong smell of gas.

Mr. W. Cupid, outdoor foreman to the South Metropolitan Gas Company, said about three o'clock on the afternoon of the accident he opened the road at the south-west corner of the bridge, and found a 3in. main cracked about half-way round and split lengthways about 6in. The crack was about the thickness of a sheet of a paper. It was centrally over a culvert which passed across the roadway. The main passed about an inch above the electric mains.

In reply to the **City Solicitor**, the **Witness** said the crack round the pipe might have been leaking two or three days, or it might have been caused by the explosion.

Mr. R. Thompson, in the service of the electric lighting company, said he last examined the boxes on the bridge on the 25th ult., and there was no smell of gas in them then.

Mr. J. P. Buck, superintendent of street work for the electric lighting company, said that when the explosion was reported to him he went to the bridge and found a strong smell of gas coming from the manhole and the gratings. The electric mains were uninjured except for a few dents caused by stones. Twelve men were constantly employed in searching for gas in the electric light boxes.

Mr. T. Blythe, foreman to Messrs. Mowlem and Co., said in January last his employers were engaged by the City architect to carry out the construction of new gullies on the bridge—one on the east side and one on the west side at the south end of the bridge. He cut away the brickwork from the old grating above the culvert and close to the gas pipe, but he did not touch it. The particular part of the pipe found cracked they did not go near. He thought the frost and rain might have caused the crack in the pipe owing to its being so close to the surface.

Mr. F. H. Jackson, in charge of the electric lighting company's plant, produced an automatic voltmeter record showing that at the time of the explosion there was no record of any disturbance at the company's works.

Mr. Livesey observed it was impossible to prevent all escapes of gas. They had many difficulties to contend with in connection with this matter. One of these was the heavy steam-rollers. Although their mains had to a great extent been placed deeper since these were brought into use, the company could not relay the whole of their mains, as that would mean taking up all the streets in South London. Then the sewers were laid underneath their mains, and pipes were sometimes broken in this way. He could not suggest any reason for the explosion. Generally, when there was an accident of the kind they were able to trace a light to somewhere, but in this case they were unable to do so.

The proceedings then terminated.

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DOVER.

The explosion which occurred at Dover on Thursday of last week, as reported in our last issue, took place whilst an employé was working in one of the manholes at the lower end of Snargate-street. The man was using at the time a flare lamp, when an explosion occurred of some gas which had accumulated in the next manhole below, and blew off the cover of the manhole, but did no injury to anyone. The draught had blown the gas up the pipe which connects the two manholes, and had been ignited by the workman's lamp, the lamp being blown out of the man's hand. As stated last week, the explosion was not due to any sparking, as the current has not yet been switched on to the mains. Moreover, it is intended to endeavour to prevent explosions when the company set to work by filling the boxes with bags of sand and providing the transformer-chambers with ventilating gratings.

ROCHESTER.

In the town of Rochester, which was the scene of an explosion the previous week, another explosion took place on Saturday in a chamber beneath the pavement. It occurred at the same spot as the previous explosion, and apparently from a similar cause—namely, an escape of coal gas coming into contact with an electric spark. Another explosion is reported to have occurred on Wednesday evening

EASTBOURNE.

An explosion occurred on the 25th ult. near the junction of Terminus and Cornfield roads. One of the workmen of the Eastbourne Electric Light Company was engaged in testing a piece of cable between two boxes. A jointer, who was assisting him, was using a spirit lamp at a box, when there was an explosion of gas, which blew off the tops of three boxes on the other side of Terminus-road. A black smoke rose from the box for a few seconds, and there was a strong smell of gas, plainly indicating the cause of the explosion, which was not in any way due to the electricity, as the engines were not running at the time. This is the first accident which has taken place in Eastbourne during the time the electric light company has been at work.

THE GOVERNMENT AND TELEPHONY.

The deputation from the London County Council which had an interview on Monday with the Postmaster-General at the General Post Office on the subject of the telephone service of London, very properly received a direct snub. The deputation, which was introduced by Mr. Benn, M.P., consisted of Mr. Dickinson, Mr. Edwin Jones (the chairman of the Telephone Committee of the Council), Mr. N. W. Hubbard, and Mr. J. Thornton. The Postmaster-General was accompanied by Sir Robert Hunter, Mr. Spencer Walpole, and Mr. J. C. Lamb.

Mr. J. W. Benn, who introduced the deputation, said that what the Council desired was that a committee should be appointed to consider the case of London in the matter of telephones.

Mr. W. Dickinson, the deputy-chairman of the Council, said at present the National Telephone Company had a monopoly which rendered competition almost impossible, and they suggested that restrictions should be imposed, or that the Government should take over the direction of the telephones, or that they should be given over to the County Council. He argued that the maximum cost of a telephone for the year should not be more than £10, and further asked that a committee might be appointed, so that the whole matter could be threshed out, as at present the terms of the agreement were such as to render it impossible for competitors to carry on business. The agreement afforded such facilities to the National Telephone Company as practically placed it in a most advantageous position to carry on its business and increase its profits. The Council said if that was so, there ought to be conditions which would limit the charges and profits of a company which enjoyed a monopoly.

The **Postmaster-General**, in reply, pointed out that it was asked that the Government should go back, not only upon a policy approved by Parliament in 1892, but upon an agreement which was actually signed by the Government of the day with the two telephone companies. What they were proposing to do under this agreement was for the State to take over a great portion of the telephone work from the telephone company. That was to say, the taking over the whole of the trunk system, and by this agreement they were making a long stride in the direction of the telephone system passing under the control of the State. The Government were carefully considering the whole question, but after the experience in 1870 in connection with the telegraphs, they needed to give the matter the most serious consideration before they decided to compulsorily purchase. Nothing could be more detrimental than a competing system. No monopoly had been given to the National Telephone Company. If they failed to provide a reasonably efficient service, the Post Office had the right to set up a telephone, or of granting another body a license to carry on a competitive system, but, speaking generally, he was confident that a competing system was a bad arrangement for an effective telephone system in any given area. The telephone was a luxury for the commercial and wealthy classes. They could not make it an ordinary means of communication for the great masses of the community, and he doubted the wisdom of any municipality taking it up. With regard to London, he was prepared to state that after these agreements were ratified London would be practically in the same position that it was before. They had safeguarded the position of local authorities by words which were amply sufficient to prevent anything being done without the previous consent of the County Council. The Government was perfectly free to carry on the telephone system itself or to give powers to other authorities.

THE RECENT EXPLOSIONS IN ST. PANCRAS.

BOARD OF TRADE REPORT.

We give below the report, which is dated January 18, 1895, of Major P. Cardew to the Board of Trade concerning the enquiry which he held into the circumstances connected with two explosions which took place in the electric light conduits in Euston-road on December 29 last :

I have the honour to report that, in accordance with your instructions, I held an enquiry on the 10th inst. as detailed above. The enquiry was held in the St. Pancras Vestry Hall. Prof. Robinson, the consulting engineer to the Vestry of St. Pancras, represented the Vestry, who are the owners of the electric light conduits. Mr. Bassett Hopkins and Mr. Gunyon represented the London County Council, and Mr. Foulger, engineer to the Gaslight and Coke Company, represented his company. I attach a transcript of the shorthand writer's notes of the evidence given at the enquiry. I also append to this report a return, furnished by the metropolitan police, of previous explosions which have occurred in connection with the system of electric lighting mains laid down by the St. Pancras Vestry

The supply of electrical energy for lighting and other purposes in this district is provided by the St. Pancras Vestry, who are the undertakers under the St. Pancras Electric Lighting Order, 1883. The greater portion of their system of mains consists of bare copper strip, supported on porcelain insulators, fixed about 6ft. apart with intermediate distance-pieces, in a conduit which in general is constructed of brickwork and cement concrete; but in portions at road crossings, or at places where sufficient depth is not obtainable to suit this construction, the conduit is formed by means of a cast-iron pipe 8in. in diameter. At intervals, which vary according to the requirements of the locality, street boxes or chambers have been made giving access to the mains for purposes of jointing, testing, etc. These are formed of brickwork in cement, and are closed in the usual way with an iron cover filled in with York stone. These street boxes are generally of considerable internal capacity and allow of a man getting into them to effect cross connections or other operations on the mains. The mains are laid on the three-wire system, and consist of a positive, a negative, and an intermediate main, the pressure between the positive and negative mains being rather over 200, and that between either and the intermediate main rather over 100 volts.

General Account of Explosions.

It appears that at 12 midnight on the 29th ult., Police-constable James Diprose, 436 D, was on duty at the corner of Gower-place and Endsleigh-gardens, and heard the report of an explosion in the direction of the Euston-road. Immediately afterwards a second explosion occurred at the corner of Endsleigh-gardens and Euston road, which he witnessed, and he saw the cover of the street box at this corner projected about 20ft. into the air. This cover was afterwards found to have been broken. A few yards to the westward, along the Euston-road, he found the cover of another street box displaced about 8ft., and beyond this again, for a distance of 30 yards, the pavement had been raised over the electric conduit by about 2in. Two men, Charles Govier and David Petrie, sustained injury by these explosions. The former attended the enquiry, and stated that they were walking together along the Euston-road when the first explosion took place: he saw a flash in the ground, was hurled into the air, and came down on his back. He struggled to his knees, when the ground heaved up, probably from the effect of the second explosion, and he was thrown into the gutter On getting to his feet he found Petrie in a dazed condition, clinging to the railings. They were assisted to the University Hospital where their injuries were attended to, and they were able to leave in a short time. The house surgeon's report was stated to be to the effect that Govier had sustained a bruise in his side, and Petrie a sprained ankle—both mild cases.

According to the evidence of Mr. Baron, the chief engineer and manager of the St. Pancras electric lighting station, and from my own inspection, I find that the street boxes in which the explosions occurred were numbered 26A and 27. They are about 10 yards apart, and the conduit between them is an 8in. iron pipe. The upheaval of pavement took place west of No. 26A, where the brickwork and cement conduit is in use. No external disturbance was apparent above the iron pipe. I had the whole length of this pipe exposed to view, as it appeared to me that possibly electrolytic action might have been in progress from a connection between one of the mains and this short length of pipe, and that this might have damaged service pipes or mains of gas or water in immediate proximity. There was, however, no trace of any such action. The brickwork conduit had been seriously damaged, the top being mostly shattered, and the bottom cracked to a considerable extent. The length of the portion so damaged is about 30 yards. The whole of this was opened up, and I closely inspected the conductors, but could not discover any sign of electrolytic action or of any electric arc or short circuit having taken place. In fact, these conductors are practically in as good condition as when first laid.

At several of the insulators, more especially in the street boxes, there was an incrustation of a saline material in the vicinity of the

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negative conductor; this was distinctly damp, and no doubt would cause in the aggregate a serious leak. The tendency to the formation of this incrustation in the case of bare conductors used for electric lighting currents has been observed in several previous cases. The insulation resistance of this section of the mains was taken by Mr Thomas, the outdoor inspector, the day after the explosion, and was found to be only 330 ohms for the negative and 110 ohms for the intermediate mains in a short length of about 100 yards. That such a very low insulation as this is not an exceptional case on this system of mains is evident from a copy of a report on some tests of mains handed to me by the chief engineer, by which it appears that in May and June last year the insulation of the negative main in sections in or about the Euston-road was found as low as 150, and even 80 ohms, while in other parts very low insulation of this main was found, in one case only 40 ohms.

The chief engineer stated that he smelt coal gas immediately after the explosions in street box No. 27, in which the second explosion took place. Mr. Thomas, the outdoor inspector, stated that he smelt a strong smell of gas in a neighbouring street box, No. 26, on the 30th ult., and also on the 31st ult., when he drew the attention of Mr. Gunyon, engineer to the London County Council, to the smell, who also perceived it. Edwin Benyon, an electrical jointer in the employ of the Vestry, also smelt gas in No. 26 immediately after the explosion.

It appears that the street boxes are systematically examined for the presence of water or gas at intervals of from four to six days, and that gas was reported in No. 27 on the 13th ult. On the other hand, both No. 26A and No. 27 had been examined on the 28th ult., probably about 36 hours before the explosions took place, and were found free from gas, and Mr. Foulger, the engineer to the Gaslight and Coke Company, stated that the tests made by his company since the explosion had failed to indicate any leakage of gas in the neighbourhood, nor could I detect any smell on the 31st ult. or on the day of the enquiry. Since the enquiry, however, Mr. Foulger has informed me that a 4in. main was found to be leaking on the 9th inst. near the entrance to the London and North-Western Railway, Euston-square, and from information received from the Vestry it appears that the position of this leak was about 80 yards from the electric light conduit. The electric lighting officials admit that they frequently discover accumulations of gas in their street boxes, and the returns furnished by the police gives particulars of six explosions, all of which were probably caused by the firing of an explosive mixture of gas and air in connection with the electric lighting mains in St. Pancras.

It has been suggested that in the particular case now under consideration the explosive gas was derived from the sewers, but I do not think this at all a probable explanation. Mr. Foulger suggested at the enquiry that the gas might have been hydrogen generated by electrolytic action. This is certainly a more tenable proposition, and I took care to examine the conduits and conductors for any material evidence which might support it. No trace of such action was, however, discoverable.

After careful consideration of the evidence and of my own investigations, I am of opinion that the explosions were caused by the firing of a mixture of coal gas and air by an electric spark. I account for the presence of the coal gas by leakage from the mains of the Gaslight and Coke Company at one or more points in the vicinity of the electric light conduits; percolation of the escaped gas along the lines of gas and electric mains, which are parallel and in close proximity, where the soil has been frequently disturbed; and entry into the electric conduits and boxes, wherever small openings may exist, which from the construction and materials used will certainly be the case at many points. The gas would naturally percolate into the open space provided by the electric light conduit, and this would be facilitated to some extent by the small amount of heat produced by the electric current in the mains. It is probable that since the general adoption of wood pavement, and other forms of pavement which prevent the escape of gas from the soil directly into the open air, the danger of its percolating into underground chambers has been materially increased. The means provided by the Vestry for the immediate escape of any gas from their conduits are in my opinion totally inadequate, and even a slight leakage of gas into the conduits would be likely to accumulate until the proportion of gas in the air reached that necessary to form an explosive mixture.

The occurrence of an electric spark was, I think, probably a result of the formation of the salt incrustation on the insulators as mentioned above. This, no doubt, acts to some extent as a conductor, and if a piece break away, a small spark would very likely be caused. There are many other ways in which an electric spark might have originated, especially with this system of mains, but from my examination I think the cause suggested above the most probable. It is true that at about the time of the explosions the electrician on duty at the generating station observed a momentary fall of pressure, which probably indicated a sudden rush of current lasting for a very short time, but I am inclined to consider this occurrence as an effect rather than a cause of the explosions, since I could find no trace of any electric arc. It is possible that the intensely heated gases of the explosions may have allowed of the passage of a considerable current, and a number of partially conducting bridges of solid materials may also have been formed during the progress of the explosion connecting the oppositely-charged mains

The Vestry of St. Pancras should lose no time in removing the two existing causes of danger which I have indicated above—viz., the possibility of an accumulation of coal gas in their conduits, and that of the occurrence of an electric spark at their bare conductor mains. This system of mains and conduits was selected, I believe, mainly for economical reasons, and no doubt it has advantages in this respect, but these economical advantages must not be reaped at the expense of the safety of the public using the streets.

The Vestry were, I understand, advised by Prof. Robinson after the serious explosion which occurred on January 12, 1894, in a street box in Endsleigh-gardens, close to the position of the recent explosions, to carry out a system of efficient ventilation wherever possible and in a report on this accident, which was forwarded to the Vestry by the Board of Trade, I also advised this; and further recommended that, where possible, two small chambers should be substituted for the large ones at present in use as street boxes, and that the low insulation of the negative main, which was then, as now, a very noticeable defect, should be remedied.

Sufficient attention has not, I consider, been paid by the Vestry to these recommendations. It was stated by Mr. Baron at the enquiry that there are only 11 ventilating-pipes and three ventilating-covers to street boxes for a total length of 6½ miles of conduit, and the nearest ventilating-pipe was about 300 yards from the scene of the explosion. None of the large street boxes have, it appears, been divided into two smaller ones, as suggested by me, and the attempts made to remedy the serious leakage on the negative main have not so far been successful.

I am of opinion that the Vestry should immediately provide a thorough system of ventilation, or means for the immediate escape of gas from their conduits and street boxes, should reduce the empty space available for accumulation of gas in their street boxes as far as possible, and should carefully guard against the dangerous formation of an incrustation of salts on the insulators of the negative main by frequent inspection and by protecting these insulators against drip from the condensation of moisture on the iron lids of the street boxes.

RETURN giving particulars of all cases of explosions known to police which have occurred in the street boxes and culverts within the St. Pancras district since January 1, 1890:

Division D, November 10, 1894, 5.50 a.m., Tottenham Court-road.—The plate of a manhole, belonging to the St. Pancras Vestry, was broken, probably caused by being forced out of the aperture by foul air.

Division E, January 12, 1894, 5.10 a.m., Endsleigh-gardens and Euston-road (corner of).—The cover of a manhole, belonging to the St. Pancras Vestry, was blown out by an escape of gas, which exploded with a loud report. No personal injury.

Division S, December 28, 1892, 10.30 a.m., Cumberland-terrace.—Iron covers of culverts, belonging to the St. Pancras Vestry, were blown out by an accumulation of gas in the culvert.

Division S, December 29, 1892. 12.20 a.m., Cambridge-place.—Iron covers of culvert, belonging to the St. Pancras Vestry, blown out by an accumulation of gas in the culvert.

Division S, January 24, 1893, 4.59 p.m., Euston-road (near George-street), and Euston-road (near Melton-street).—Switchdoor to electric light post, belonging to the St. Pancras Vestry, blown off its hinges and shattered by an accumulation of gas in the culvert.

Division D, December 20, 1894, 12 night, Endsleigh-gardens and Euston-road, corner of.—Two iron plates to manholes, belonging to St. Pancras Vestry, blown out, supposed by an accumulation of escaped coal gas in electric channel. Two persons slightly injured and flagstones displaced about 440 yards.

LEGAL INTELLIGENCE.

FARMER v. THE WATERLOO AND CITY RAILWAY COMPANY.

This case was heard on Friday before Mr. Justice Kekewich in the Chancery Division of the High Court of Justice.

The case raised a question of very great importance to owners of property in the Metropolis—namely, whether the numerous companies now being projected for constructing underground railways are entitled, under what appears to be a common form clause now introduced into underground railway Acts, to tunnel through the subsoil under houses without being required to purchase the land and houses above. In the present case the defendant company were incorporated by the Waterloo and City Railway Act, 1893 (which incorporated the Lands Clauses Consolidation Act, 1845), for the purpose of constructing an underground railway from the neighbourhood of Waterloo Station to Mansion House-street, City, and by Section 5 they were empowered to "enter upon, take, and use" such of the lands described in the deposited plans and books of reference as might be required for that purpose. Under Section 7 the mode of construction was required to be by tunnels, and by Section 7 the motive power for the traffic was to be either electricity or cable traction. Then Section 36 provided that all persons empowered by the Lands Clauses Consolidation Act, 1845, to convey lands might grant easements. By Section 84 landowners might be required to sell parts only of lands and buildings. Then Section 85 enacted as follows: "With respect to the lands described in the second schedule to this Act which the company are by the provisions of this Act authorised to enter on, take, and use for the purposes of the railway and works, the company shall not be required wholly to take those lands, or any part of the surface thereof, or any houses, buildings, manufactories, and premises therein, or any cellar, vault, or other construction held or connected therewith, but the Company may appropriate and use the subsoil and under-surface of any such lands; and if the company require to take, use, pull down, or open any such vault, cellar, or arches as aforesaid, they may purchase, take,

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and use, and the owners of and other persons interested in any such vault, cellar. or arches shall sell the same for the purposes of the railway and works, and the purchase of any such cellar, vault, or construction shall not in any case be deemed the purchase of a part of a house or other building or manufactory within the said Section 92 of the Lands Clauses Consolidation Act, 1845. But nothing in this section contained, nor any dealing with the lands in pursuance of this section, shall relieve the company from the liability to compensation under the sixty-eighth section of the Lands Clauses Consolidation Act, 1845, and every case of compensation to be ascertained under this Act shall be ascertained according to the provisions contained in the Lands Clauses Consolidation Acts." The object of this section was to create an exception to the general law that an owner of land is entitled not only to the surface, but down "to the centre of the earth," as well as "*usque ad cælum*," and therefore cannot be compelled to sell any part of a vertical stratum of his land without being paid for the entire stratum ; and also partially to repeal the law as laid down by the Lands Clauses Consolidation Act, 1845, and the numerous decisions upon it, that a railway company requiring to take land having a house upon it is bound to take and purchase not only the land, both surface and subsoil, but the house upon it and every part of the house. The second schedule referred to in Section 85 described "lands, etc , in respect of which easements only may be taken," the "lands, etc.," being lands and the houses on them situate in the parish of Christchurch, Southwark, and some of which belonged to the plaintiff as tenant for life. In July last the plaintiff received from the company a notice that they required to "appropriate and use" the subsoil under his property as shown on the accompanying plan, and at a depth not less than there indicated. The plan showed that the company proposed to construct their tunnel at a considerable depth below the cellars of the houses above. Beyond this notice the company had not served any notice to treat or paid or deposited any compensation, or given a bond, as provided by Section 85 of the Lands Clauses Act. The company having recently commenced borings under the plaintiff's land for the purpose of constructing their tunnel, the plaintiff commenced this action, and now moved for an interim injunction to restrain the company from entering upon or under the premises described in the notice, or any other property in the said parish of Christchurch, Southwark, belonging to him until the company had complied with the provisions of the Lands Clauses Act and the special Act.

Mr. Channell, Q.C., and **Mr. Methold**, for the plaintiff, contended that the word "appropriate" in Section 85 of the special Act did not mean appropriate without payment, and that so to construe the section would be contrary to every principle upon which railway Acts were passed. The company were bound under the Lands Clauses Act to buy the necessary vertical slice of the plaintiff's land before they could use any part of the subsoil for their tunnel.

Mr. Cripps, Q.C., and **Mr. Ingle Joyce**, for the defendant company, contended that Section 85 of the special Act had introduced a new procedure applicable to such cases as the present, and intended to supersede the cumbrous machinery of the Lands Clauses Act, while protecting the landowner; that the tunnel would be at a great depth, so that the injury (if any) caused by it would be merely nominal. If, however, any injury should result to the plaintiff, he could obtain compensation under Section 68 of the Lands Clauses Act. So that the company might take the subsoil under their special Act, and leave the plaintiff to compensation under that section.

Mr. Justice Kekewich said that provisions drafted by way of exceptions on such a code as the Lands Clauses Act were certain to give rise to difficulties which could not ordinarily be settled without more than one decision. But upon the present case his Lordship confessed he felt no doubt whatever. The defendants, the railway company, were incorporated by a special Act in the usual way, which Act incorporated the Lands Clauses Act. They were authorised to take certain lands, including lands of which a lateral stratum only was required by them in the present instance. Instead of leaving the rights of the company and the landowner to the operation of the Lands Clauses Act, it seemed good to the Legislature to introduce into the special Act a special provision ; but his Lordship thought that this special provision must have reference to the general provisions which were none the less applicable because of the special provision. This special provision was comprised in Section 85 of the company's Act, which began thus : "With respect to the lands described in the second schedule to this Act which the company are by the provisions of this Act authorised to enter on, take, and use for the purposes of the railway and works." Stopping there, that was the ordinary form of language in an Act of this kind. If the company desired to enter upon any part of these lands in the ordinary way they must proceed in the ordinary way, by notice to treat, to be followed by agreement or otherwise. But the section went on to say that the company were to be entitled for their benefit not to take the lands in that way, notwithstanding that they required to use those lands for the purposes of their undertaking. The section said, "the company shall not be required wholly to take those lands or any part of the surface thereof, or any houses, buildings, manufactories, and premises therein, or any cellar, vault, or other construction held or connected therewith." All those exceptions were directed to the provisions of the Lands Clauses Act which were well known, and to which, therefore, his Lordship did not intend to refer, and to the decisions which had construed those provisions. In this section there were no provisions as to what the company were to do if they did less than "take and use." Mr. Cripps said that this was a question of procedure. As at present advised, his Lordship was of opinion that the procedure was precisely the same whether the company entered on and took and used the lands, or whether they took any part of the lands, which they could not do but for the provisions of this section. He was of opinion that the provisions of the Lands Clauses Act must be treated as incorporated into the special Act for the one purpose quite as much as for the other. But this was only one point made by Mr. Cripps. The section went on to say, "the company may appropriate and use the subsoil and under-surface of any such lands." It was unnecessary to refer to the next clause, as to vaults, cellars. and arches. Independently of that special provision it was quite clear that the company could not take any part of the subsoil and under-surface from an unwilling landowner. He might say, "The land is mine from the centre of the earth to the heaven, and if you take any part of the subsoil you must take the whole of the land." In consequence of that right of the landowner this modification of the law was here introduced. The question was, What was the meaning of the words "appropriate and use?" Without referring to the definition of the word "appropriate" in the "Century Dictionary," his Lordship found, what was still better, a definition of it in Metropolitan Railway Company *v.* Fowler. It was defined by Lord Watson as follows: "To appropriate, according to its natural meaning, is to take and keep a thing by exclusive right; and, as I construe their Act, the authority which it confers upon the company is to take and exclusively possess as much of the subsoil below highways as may be required for the purposes of the undertaking." And it would be observed that the House of Lords held that what the company took in that case was "land." In taking so much of the subsoil they required, they excluded all other persons and made it their own. There was no possibility of reverter ; it was to belong to the company exclusively. Leaving the question of procedure, his Lordship would apply the much earlier principle of law that no one was allowed to take another man's property, notwithstanding it might be required for the general purposes of a public undertaking, without paying for it. Then Mr. Cripps said that the plaintiff might be "injuriously affected" within the meaning of the Lands Clauses Act, so as to entitle him to compensation under Section 68. That section covered purchase-money, and was therefore directly applicable to a case of this kind Unless the Legislature had distinctly said that the company might take the subsoil without paying for it, they could not be allowed to do so. On both these grounds his Lordship was of opinion that the company could not be allowed in any way to deal with this property except upon the terms of their paying a sum into Court. Then arose a question whether the word "appropriate" came within the "possession" clauses in the Lands Clauses Act. As at present advised, his Lordship thought it did, though he would not now pronounce an actual decision upon it; but perhaps the parties might not think it worth while to discuss that question. Upon the whole his Lordship held that the plaintiff was entitled to an injunction.

As the parties consented to treat the hearing of the motion as the trial of the action,

His **Lordship** made a declaration that the defendant company was not entitled to appropriate and use the subsoil under the plaintiff's property, or any part thereof, until they had complied with the provisions of the Lands Clauses Consolidation Act, 1845, in reference to the compulsory purchase of land. The defendant company to pay the costs of the action.—*The Times.*

COMPANIES' MEETINGS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

An extraordinary general meeting of this Company took place on Tuesday at the Cannon-street Hotel, Mr. J. S. Forbes being in the chair.

The **Chairman** moved resolutions making certain alterations in Clauses 10, 11, 16, 20, 41, 41A, 59, and 65 of the articles of association. (We gave these proposed changes in full in our "Business Notes" on January 25.) The Chairman stated that the alterations were required in order to meet the wishes of the Stock Exchange before granting the Company a quotation. He went into the details of the various alterations in the clauses which were required by the Stock Exchange, explaining their effects.

The resolutions having been seconded by **Major Flood-Page**, they were put *seriatim*, and carried unanimously.

The **Chairman** pointed out that one of the principal advantages they expected to secure by the fusion of the two companies was that they might get a quotation on the Stock Exchange for the various classes of shares. They had a quotation for their Swan ordinary shares, but not for the fully-paid. In the Edison Company they had no quotation for either class of shares. He thought, however, that under the resolutions which had now been passed they would get a quotation for all their ordinary shares in the Edison and Swan. They had now emerged from protection into the free air of competition. He thought, however, he might state generally that the consequences of competition were not so disastrous to them as many people predicted would be. The Company had succeeded in establishing for its business a certain reputation. The trade mark of Edison and Swan still had its magic influence. They turned out a good article, and although they had been obliged to descend to the arena as regards price, he did not think that when the results of the first year's working were submitted to the proprietors they would find they had cause to be greatly depressed.

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YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY.

An ordinary general meeting of the shareholders of this Company was held on Tuesday at Leeds. Mr. Grosvenor Talbot occupied the chair.

The **Chairman**, in moving the adoption of the report and statement of accounts, which were given in our issue of last week, said the directors felt that there was a certain amount of satisfaction in appearing before the shareholders. They had been able to earn a dividend of 4 per cent., and in addition to the dividend they had also earned almost an equal amount, which they were applying to other purposes. He believed that the result of the last year's working, which was the first complete year of their Company, was equal to the result of almost any country station in England. Their customers had full confidence in the Company, and almost all the new buildings which were being erected, or which had recently been erected, in Leeds were dependent entirely upon the electric light as an illuminant. On December 31, 1893, as the result of eight months' working, they had installed what was equal to 10,647 8-c.p. lamps. At the close of last year they had 19,858 lamps installed. They delivered, in units, in the eight months of 1893, 125,000; and in the 12 months of 1894 they delivered 291,113—that was to say, in 1893 they delivered 15 620 units per month, and in 1894 24,260 units per month. That statement of the amount per month might be a little misleading without explanation. In 1893 there were four good months in which they were not working, and therefore the comparison was rather too favourable for last year's working, but the increase was eminently satisfactory. They had now, in immediate prospect, the whole of the lighting of the Leeds Town Hall and Municipal Buildings, equal to about 6,000 8-c.p. lamps. They had also offered to the Corporation to light every portion of the streets or markets which they chose with arc lamps. Messrs. Fowler had agreed to take their 100 h.p. engine, and to replace it with a 400 h.p. engine, and that was now about to be done. As to the future, the directors felt that the price of the current was one of the great objects which they had to deal with, and they felt sure that by reducing the price they would immensely increase the sale. They had decided that from July 1 next the maximum price should be reduced from 7d. to 6d. per unit. They proposed some time during the next spring to extend their mains.

Mr. R. W. Eddison seconded the resolution, which was adopted.

Mr. J. T. Pearson (Melmerby) and Mr. R. W. Eddison, the retiring directors, were re-elected; and Mr. John Gordon, jun., was also re-elected as auditor.

CITY AND SOUTH LONDON RAILWAY COMPANY.

The ordinary general meeting of the City and South London Railway took place on Friday last at Winchester House, Old Broad-street, E.C. Mr. Charles G. Mott, the chairman, presided.

The **Chairman**, in moving the adoption of the report and accounts, which we published in our last issue, stated that he thought the shareholders would agree that during the past half-year the line had made, on the whole, very satisfactory progress. During that time the ordinary passengers, exclusive of season tickets, had increased by 182,298 over the corresponding period of the previous year. That was a considerable increase of the traffic of the line. They were aware that in the early stages of this line they had a very great deal of prejudice to overcome. Year by year it had been the endeavour of the Board to get rid of this prejudice. He was glad to say that, although it had not disappeared, it had immensely diminished, because they had been able to show that the line was perfectly safe, that it was a comfortable mode of conveyance, that it was absolutely punctual, that the lifts were perfectly safe, and that there was no danger whatever from the electric current. One of the most important questions, and one of the most anxious with them, had always been the question of the lifts. These involved constant and careful watching. The fact that those lifts had gone up and down 2,500,000 times without the slightest accident, or any difficulty of any kind, reflected the greatest credit upon those who had them in charge. In regard to the question of the traffic on a line of this kind, one of the greatest advantages of electric traction over locomotive machinery was that in working it there was very little wear and tear. Many of their locomotives had already run some 150,000 miles each, and were very little worse than when they started. That would show them one of the advantages which they would derive in future from the electric working of the railway. Referring to the accounts, he said that they had paid off debenture bonds £9,100, as well as a loan of £1,000. Those debenture bonds had been substituted for debenture stock, which had been issued at a little over 3 per cent. In addition to that, they had issued £4,100 of preference shares and £2,841 debenture stock, and they had received in premiums on the issue of the debenture stock £3,038, making a total of £10,179. They had expended during the half-year £2,936 upon rolling-stock and the new motor-car trains. Out of the balance of £7,783 they had increased the balance at the bankers by £5,850, they had paid off the loan of £1,000, and they had reduced their outstanding accounts by £1,574, thus more than accounting for the capital raised. They had provided the increase at their bankers for the purpose of paying off those debentures. The capital was reduced by the transference of the construction reserve which had been standing in the books for some time, so that practically this account stood at an increase of only a few hundred pounds for the half-year. The receipts from passengers showed an increase of £1,332, and the season tickets an increase of £140. The parcels showed an improvement of £24. On the other hand, there was a decrease in the rents received of £51, and in the sundry receipts of £27, leaving the net increase at £1,431. In the expenditure there were the following decreases: maintenance, £37; locomotive department, £23; traffic expenses, £43; carriage repairs, £73; and law charges, £73. In the result, there was an available balance in the revenue account of £10,919, and the dividend they recommended was double the amount they paid in the corresponding period of 1893. Their working expenses were reduced from 64·6 per cent. to 60·9 per cent., and deducting the cost of working the lifts, the percentage was reduced to about 51 per cent. The locomotive expenses per train mile had now come down to 6d. from 6·22d. The number of trains run during the half-year had been 73 208 against 71.143, an increase of 2,065, and the train miles were 230,604, against 224,101. Despite this increased train mileage, the receipts per train mile had been increased from 2s. 0½d. to 2s 1½d., and the receipts per passenger from 1·66d. to 1·77d. It was absolutely necessary to provide accommodation for their customers. They had done everything they could to increase the number of trains, but now, under the regulations of the Board of the Trade and under the peculiar circumstances of having a terminal station with only one line of rails, and with two lines of rails converging into it, they could not see their way to increase the number of trains run. Then the question arose, could they increase the size of the train? With that view they had been endeavouring to get rid of the locomotive and put another carriage on their train. After many experiments, they had at last got such a train successfully completed. The Board of Trade officers had approved it, with slight alterations, and it would be brought into running in the course of a few days, in order to be tested with passengers. The advantage would be that they would get another carriage. Except the King William-street Station, all their stations were capable of taking much longer trains, and two or three times as many as they now ran. It was a pity to see a line like theirs only used to the extent of one-third of its capacity simply because of the condition at the King William-street Station. The shareholders ought to proceed at once, under the Act they had obtained, with an important extension of their system. The directors proposed to go as far as Finsbury-pavement—opposite the Moorgate-street Station. They would start from the Borough Station as a branch, in order to get a station close to the London Bridge Station, the Brighton Company having promised to make a connection with its platforms by means of an underground passage. It would also be in connection with the terminus of the proposed Great Northern and City Railway, the prospectus of which had just come out, and which would, he hoped, obtain its money and construct its line, in which case they would have an exchange of traffic with it, so that their passengers would be able to go through on to the Northern system, and they would thus tap the enormous population that lay along the route of that line. It was believed that the sites could be obtained on terms which would be regarded as highly satisfactory by the shareholders, but of course the negotiations would take some time. What the directors asked was that the shareholders should give them authority to proceed for the acquisition of those sites for the ultimate purpose of carrying out the extension, but the Board did not propose to enter into any agreement involving any large expenditure without the specific authority of the shareholders.

Mr. Sampson Hanbury seconded the motion.

Sir Thomas Hanbury proposed the following amendment to the sixth paragraph of the report, relating to the extension of the line—namely, "That it is not prudent to proceed at present with the proposed extension of the line."

Mr. J. T. Middleton seconded the amendment.

After some discussion, a vote was taken, and ultimately the adoption of the report was carried unanimously.

After a dividend of 5 per cent. per annum had been declared on the preference shares and 1¼ per cent. per annum upon the consolidated ordinary stock, the retiring director (Mr. C. G. Mott) was re-elected, and Messrs. Turquand, Youngs, and Co. reappointed auditors.

A special general meeting was then held, at which the Bill to further extend the time for the purchase of lands for the railway and for raising the additional capital was approved.

COMPANIES' REPORTS.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

Directors: S. Wm. Silver, Esq. (chairman); Abraham Scott, Esq.; Matthew Gray, Esq (managing director); Robert Henderson, Esq.; the Hon. Henry Marsham; A. Weston Jarvis, Esq.

Report of the directors for the year ending December 31, 1894, to be presented at the thirty-first ordinary general meeting of the shareholders to be held at the Cannon-street Hotel, London, on Thursday, February 14, at 12 o'clock.

The annexed accounts show the net profit for the past year to be £41,961. 15s. 9d. Adding £28,952. 1s. 7d. brought forward, and deducting £25,000 interim dividend paid in July, there remains a disposable balance of £45,913. 17s 4d. The directors recommend the distribution of a dividend of 10s. a share, free of income tax, amounting to £25,000, making, with the interim dividend, a total payment for the year of 10 per cent., and leaving

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£20,913. 17s. 4d. to be carried forward. The trading for the year has been comparatively unsatisfactory. Competition has reduced both the volume of general business and the rate of profit, and there have been but few orders for cables. The Silvertown and Persan factories are in good order. The Hon. H. Marsham and Mr. Jarvis, the directors retiring by rotation, offer themselves for re-election.

BALANCE-SHEET TO DEC. 31, 1894.

Dr. CAPITAL AND LIABILITIES.	£	s.	d.
Authorised share capital	812,000	0	0
Share capital—amount paid on issue of 50,000 shares of £10 each	500,000	0	0
Mortgage debentures	200,000	0	0
Reserve fund	450,000	0	0
Steamers' maintenance fund	5,000	0	0
Debts owing by the Company	31,613	19	4
Bills payable	6,186	1	9
Unclaimed dividends	49	5	0
Proposed dividend of 5 per cent.	25,000	0	0
Amount carried forward to 1895, as below	20,913	17	4
	£1,238,763	3	5

Cr. ASSETS AND EXPENDITURE.	£	s.	d.
Freehold and leasehold premises (Silvertown, Persan, London, and Liverpool), machinery, and steamships	491,486	9	7
Debts owing to the Company	146,899	2	11
Cash with bankers and in hand	14,747	2	6
Bills receivable	1,251	8	0
Stock-in-trade, including expenditure on contracts and 150 miles of cable laid	246,122	9	5
Debentures and shares in other companies	209,540	1	4
Cash, stock, etc., at Persan and agencies, after deducting liabilities	127,716	9	8
	£1,238,763	3	5

PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1894.

Dr.	£	s.	d.
Salaries, interest, rent, rates and taxes, repairs, and general expenses	61,038	4	11
Bad debts	3,014	16	6
Income tax	2 842	3	6
Depreciation written off buildings and machinery	16,019	2	0
Directors' remuneration	2,000	0	0
Balance—profit for the year carried down	41,961	15	9
	£126,876	2	8
Interim dividend of 5 per cent. paid in July	25,000	0	0
Proposed dividend of 5 per cent.	25,000	0	0
	50,000	0	0
Balance to be carried forward to 1895	20,913	17	4
	£70,913	17	4

Cr.	£	s.	d.
Gross profit, including interest on securities and after charging commission	126,876	2	8
	£126,876	2	8
Balance brought down	41,961	15	9
Amount brought forward from 1893	28,952	1	7
	£70,913	17	4

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY.

Directors: Eustace J. A. Balfour, Esq. (chairman); Latimer Clark, Esq., F.R.S. (vice-chairman); Sir John H. Morris, K.C.S.I.; Gerald W. Balfour, Esq., M.P.; Bennett Fitch, Esq., M.I.C.E. General manager and secretary, Frederic J. Walker. Chief engineer, S. T. Dobson, A.M.I.C.E., M.I.E.E.

Report of the directors and abstract of accounts for the year ending December 31, 1894. The general meeting is to be held at the offices of the Company, Carnaby-street central station, Golden-square, W., on Tuesday, February 12, at 3 p.m.

The directors, in submitting their report for the year 1894, with accounts as certified by the Company's auditors, congratulate the shareholders on the improvement shown in the result of the year's trading. The business of the Company is steadily increasing, and the building extension in Carnaby-street, now almost completed, has been made none too early. It has also become necessary to add to the plant at Carnaby-street, and orders have been given accordingly. This involves an expenditure of capital beyond the amount already at the disposal of the directors, which they propose to meet by a further issue of a part of the £100,000 4 per cent. debenture stock created last year, and of which £30,000 has already been issued. The directors regret that the item of expenditure under the head of rates and taxes has so considerably increased. This is owing to a revaluation of the premises by the Vestry, which has been upheld by the Assessment Committee. An action has been instituted by the Attorney-General on behalf of the parish, alleging a nuisance from the plant at the Mason's-yard station. This station is now only used as auxiliary to the main station at Carnaby-street. No efforts have been or will be spared to prevent annoyance to the parishioners. The net earnings of the Company during the past year have amounted to £13,468. 4s. 10d. Of this sum, £5,498 was distributed in August last in payment of an interim dividend at the rate of 4 per cent. per annum for the half-year ending June 30, 1894, on the ordinary shares, and at 7 per cent. per annum on the preference shares. The balance, £7,970. 4s. 10d., together with the undivided profit of £120. 8s. 9d. from last year's account, leaves £8,090. 13s. 7d. now to be dealt with. The directors propose to divide this amount as follows:

	£	s.	d.
(a) By payment of a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year	£3,500	0	0
(b) By payment of a dividend at the rate of 9 per per annum for the second half-year on the ordinary shares, making, with the interim dividend paid on August 1 last, a total distribution of 6½ per cent. for the year	4,495	10	0
(c) Amount to be carried forward to ordinary shareholders' undivided profit account	90	14	5
(d) Amount to be carried forward to founders' undivided profit account	4	9	2
	£8,090	13	7

Mr. H. Woodburn Kirby has recently resigned his seat on the Board, to the great regret of his colleagues. Sir John H. Morris, K.C.S.I., and Mr. Gerald W. Balfour, M.P., are the directors who retire by rotation under Clause 79 of the articles of association, and being eligible offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and being eligible offer themselves for re-election.

REVENUE ACCOUNT YEAR ENDING DEC. 31, 1894.

Dr.	£	s.	d.	£	s.	d.
A.—To Generation and Distribution of Electricity.						
Coal and other fuel, including dues, carriage, etc.	4,925	19	10			
Oil, waste, water, and engine-room stores	846	14	5			
Salaries of engineers and officers	1,274	8	6			
Wages at generating and distributing stations	3,241	16	4			
Repairs and maintenance, as follows: buildings, £156. 4s. 5d.; engines and boilers, £841. 3s. 5d.; dynamos, £163. 15s. 7d.; other machinery, instruments, and tools, £204. 10s. 5d.; accumulators, £77. 6s. 9d.; lamps (at station), £21. 19s. 9d.	1,465	0	4			
Repairs and maintenance of mains	790	6	8			
Miscellaneous expenses	98	18	10			
				12,643	4	11
B.—To Rents, Rates, and Taxes.						
Rents payable	105	8	0			
Rates and taxes	1,905	10	6			
				2,010	18	6
C.—To Management Expenses.						
Directors' remuneration	1,496	9	5			
Salaries of general manager and secretary, engineer, clerks, canvasser, etc.	2,216	19	11			
Stationery, printing, and advertising	241	19	3			
General establishment charges	281	16	0			
Auditors of Company	78	15	0			
				4,315	19	
D.—To Law Expenses.						
Law expenses				373	18	6
E.—To Special Charges.						
Insurance	172	2	3			
Expenses (other than law charges) in abating nuisances	78	12	4			
Brokerage on debenture stock	44	15	0			
Fees for testing meters	6	0	0			
Board of Trade audit	52	16	6			
Expenses *re* rating assessment	26	5	0			
				380	11	1
F.—To Depreciation.						
Depreciation on buildings	307	7	5			
Depreciation on plant, machinery, etc.	3,387	13	7			
				3,695	1	0
				23,419	13	7
Balance carried to net revenue account				13,835	16	11
				£37,255	10	6

Cr.	£	s.	d.
Sale of current, after deducting provision for bad and doubtful debts	35,042	5	11
Ditto under contract	787	10	2
Rental of meters on consumers' premises	898	6	4
Rents receivable, less repairs to houses	268	1	4
Transfer fees	42	2	6
Discounts on purchases	76	5	6
Sale of old materials, stores, etc.		6	7
Sundry fees, shareholders' lists sold, etc.	3	9	6
Income tax returned	67	18	0
Profit on sale of temporary investments	69	4	8
	£37,255	10	6

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Dr. GENERAL BALANCE-SHEET, DEC. 31, 1894.

	£	s.	d.
Capital account—amount received	230,000	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	1,224	19	4
Sundry creditors on open accounts	2,582	16	4
Debenture stockholders, for interest accrued, less tax, payable January 1, 1895	580	0	0
Unclaimed dividends	33	11	10
Capital reserve fund	15,000	0	0
Net revenue account—balance at credit thereof, £13,588. 13s. 7d.; less interim dividends paid on preference and ordinary shares, £5,498 (For proposed division, see directors' report.)	8,090	13	7
	£257,512	1	1

Cr.

	£	s	d.
Capital account—amount expended for works, less depreciation to date	227,067	7	1
Stores on hand—coal, £174. 15s. 9d.; lamps, £23. 15s. 5d.; meters and switches, £450. 0s. 7d; general, including oil, waste, etc., £1,185. 8s. 3d.	1,834	0	0
Sundry debtors for current supplied, £10,775. 7s. 3d.; other debtors, £357. 10s. 4d.	11,132	17	7
Cash at bankers (Lloyd's Bank, Limited), £2,442. 19s. 1d.; cash in hand, £34. 17s. 4d.	2,477	16	5
Capital reserve fund investments, cost of Canada 3 per cent., Cape 3½ per cent., and India 3 per cent. stock	15,000	0	0
	£257,512	1	1

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY.

Directors: Henry Ramié Beeton (chairman), William Page (managing director), William Reginald Davies, Robert Arthur Germaine, William Francis Leese. Manager: Henry W. Bowden. Secretary: W. Coupland Weir.

Report of the directors and abstract of accounts for the year ending December 31, 1894.

In submitting to the shareholders the balance-sheet and accounts for the year ended December 31, 1894, the directors beg to report that the revenue account shows a credit balance of £6,263. 15s., which, with the balance of £43. 8s. 3d. brought forward from the previous year, makes a total of £6,307. 3s. 3d. After deducting £1,898. 11s. 10d. for interest paid on £30,000 debentures, and on temporary loans, the directors recommend that the balance be dealt with as follows:

In reduction of preliminary expenses	£500	0	0
In extinction of suspense renewal account	200	0	0
Depreciation account	1,450	0	0
Dividend of 7 per cent on £25,000 cumulative preference shares	1,750	0	0
In reduction of construction business development account	400	0	0
Balance carried forward to next account	108	11	5
	£4,408	11	5

The table given below shows the progress of the Company's electric lighting business during the last five years: The increase in the lights connected during the year 1894 was equivalent to 7,429 8-c.p. (35-watt) lamps, being the largest increase since 1890, and the directors consider that the shareholders are to be congratulated upon the fact that, notwithstanding an increase in revenue of £1,632. 0s. 10d. as compared with that received in 1893, the working expenses as compared with the same period show a decrease of £400. 10s. Since the issue of the last report additional mains have been laid in various parts of the area, and to meet the continual increase in the Company's business, arrangements are being made for laying down further plant and mains during the current year. As the amount of ordinary capital appropriated to construction business development account stands at £15,000, the directors propose to gradually write down the account to that amount, and to this end they have applied £400 out of the profits of this year. The directors regret to report that they have been advised by the secretary of the Leeds and London Electrical Engineering Company, Limited (to whom this business has been leased), that their accounts for the year ending March 31, 1894, will not admit of the distribution of any profit. The £30,000 6 per cent. first mortgage debenture bonds, which were redeemable on January 1, 1895, have been paid off, and £50,000 of 4½ per cent. mortgage debenture stock has been created, of which £40,000 has been issued. By this operation the Company is provided with an additional £10,000 without any increase in the annual amount required for interest. The directors, having had every reason to be satisfied with the manner in which Mr. Henry W. Bowden discharged the duties of chief engineer, have appointed him to the post of manager. Mr. H. R. Beeton and Mr. W. Page retire from the Board by rotation, and being eligible offer themselves for re-election. Messrs. Theobald Bros., Miall, and Co., the auditors of the Company, retire, and submit themselves for re-election.

REVENUE ACCOUNT FOR THE YEAR ENDED DEC. 31, 1894.

Dr.	£	s.	d.	£	s.	d.
A.—To Generation of Electricity.						
Coal or other fuel, including dues, carriages, unloading, storing, and all expenses of placing the same on the works	2,827	14	3			
Oil, waste, water, and engine-room stores	665	4	10			
Proportion of salaries of manager and superintendents	443	16	8			
Wages and gratuities at generating station	1,140	6	4			
Repairs and maintenance as follows: buildings, £13. 0s. 1d.; engines and boilers, £165. 10s. 2d.; dynamos, exciters, motors, etc., £19. 18s. 4d.; other machinery, instruments, and tools, £93. 6s. 11d.	291	15	6			
Cartage of ashes	35	11	0			
				5,404	8	7
B.—To Distribution of Electricity.						
Proportion of salaries of manager and engineers	45	0	0			
Wages	76	16	3			
Repairs and maintenance of mains of all classes	72	10	8			
Repairs, maintenance, and renewals of transformers, meters, and other apparatus on consumers' premises	60	17	4			
				255	4	3
C.—To Rents, Rates, and Taxes.						
Rents payable	233	7	6			
Rates and taxes	154	18	8			
				388	6	2
D.—To Management Expenses.						
Directors' remuneration £1,500, less amount surrendered £1,200	300	0	0			
Managing director's remuneration	200	0	0			
Salaries of secretary and clerks	297	16	3			
Collector's salary	143	0	0			
Stationery and printing	70	0	1			
General establishment charges	141	11	1			
Auditors of Company	26	5	0			
Auditors of the Board of Trade	32	13	9			
				1,211	6	2
E.—To Law and Parliamentary Charges.						
Law charges and construction business expenses				27	0	8
To Special Charges.						
Insurances				73	1	3
Sundries.						
Doubtful debts account				72	9	7
				7,431	16	8
Balance carried to net revenue account				6,263	15	0
				£13,695	11	8

Cr.	£	s.	d.
Sale of electricity per meter at 8d. per B.T.U. (less discounts)	12,573	8	3
Sale of electricity per meter at 5d. per B.T.U. for cooking, heating, etc.	5	9	5
Rental of meters and other apparatus on consumers' premises	1,016	9	2
Transfer fees	£11 5 0		
Students' instruction	86 17 1		
Rents received	2 2 9		
	100	4	10
	£13,695	11	8

Dr. NET REVENUE ACCOUNT.	£	s.	d.
Interest on debentures paid and accrued to date	1,800	0	0
Interest on loans, deposits, etc.	98	11	10
Amount written off preliminary expenses account	500	0	0
Amount to extinguish suspense renewals account	200	0	0
Depreciation account	1,450	0	0
Amount written off construction business development account	400	0	0
Balance carried to general balance-sheet	1,858	11	5
	£6,307	3	3

Year.	Equivalent of 35-watt lamps connected.	Increase in 35-watt lamps.	Number of houses connected.	Gross revenue.	Expenditure.	Net revenue.
				£ s. d.	£ s. d.	£ s. d.
1890	13,665	9,145	248	5,010 9 2	4,624 6 5	386 2 9
1891	19,388	5,723	373	8,328 3 11	6,077 14 10	2,250 9 1
1892	23,700	4,312	471	10,688 18 6	7,851 19 6	2,836 19 0
1893	28,429	4,729	599	12,063 10 10	7,832 6 8	4,321 4 2
1894	35,858	7,429	755	13,695 11 8	7,431 16 8	6,263 15 0

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Cr.	£	s.	d.
Balance from last account	1,696	18	5
Less dividend on preference shares to December 31, 1893	1,653	10	2
	43	8	3
Balance brought from revenue account	6,263	15	0
	£6,307	3	3

Dr. GENERAL BALANCE-SHEET, DEC. 31, 1894.		£	s.	d.
300 6 per cent. debentures of £100 each, since redeemed or exchanged		30,000	0	0
Amounts received on account of issue of £40,000 4½ per cent. debenture stock		9,470	0	0
Sundry creditors on open accounts and for debenture interest accrued		6,112	1	1
Doubtful debts reserve account		250	0	0
Depreciation account—provision against depreciation of leasehold buildings and other expenditure, included in capital account		2,400	0	0
Net revenue account, balance at credit thereof		1,858	11	5
Capital—8,322 ordinary shares of £5 each	£41,610 0 0			
100 founders' shares of £5 each	500 0 0			
5,000 preference shares of £5 each	25,000 0 0			
		67,110	0	0
		£117,200	12	6

Cr.		£	s.	d.
Capital account—amount expended for works		83,847	19	10
Stores on hand at December 31, 1894—coal, £299. 14s. 10d.; oil, waste, etc., £153. 17s. 3d.; general, £138. 15s. 4d.		582	7	5
Sundry debtors for electricity supplied to December 31, 1894		5,480	0	0
Other debtors, prepaid charges, etc.		654	7	1
Cash at bankers—				
Messrs. Glyn, Mills, Currie, and Co.	£6,490 19 8			
Parr's Banking Company and the Alliance Bank, Limited	1,548 3 10			
	8,039 3 6			
Deduct cheques issued on Parr's Bank, but not presented for payment	2,173 5 0			
		5,865	18	6
Cash in hand		17	10	2
Suspense account (machinery accounts undelivered or in dispute)		165	3	8
Preliminary, debenture, and preference share issue expenses and foundation of business account, as per last balance-sheet	4,255 7 9			
Add outstanding claims paid	1 14 0			
Expenses of issue of 4½ per cent. debenture stock	201 13 1			
	4,458 14 10			
Less written off as per net revenue account	500 0 0			
		3,958	14	10
Construction business development account, as per last balance-sheet	16,757 11 8			
Addition on further adjustment of accounts	260 9 7			
	17,018 1 3			
Less written off as per net revenue account	400 0 0			
		16,618	1	3
		£117,200	12	6

The amount of electricity generated, sold, etc., for the past year (in Board of Trade units) is as follows: to private consumers by meter, 400,911; quantity used in works, 5,498; total quantity accounted for, 406,409; total maximum supply demanded, 430.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: John D. Milburn, Esq., chairman; the Hon. C. A. Parsons, managing director; Sir B. C. Brown; Colonel W. M. Angus; Colonel H. S. Dyer; John B. Simpson, Esq. Jas. Patterson, secretary. W. D. Hunter, engineer.

Report of the directors to be presented to the shareholders at the eighth ordinary general meeting of the Company to be held at 57, Westgate-road, Newcastle-on-Tyne, on Monday, February 12, at 2 30 p.m.

The directors have pleasure in again reporting that the supply of current continues to give satisfaction to the Company's consumers. The installations connected to the Company's mains during the year are equal to 3,000 10-c.p. lamps, bringing the total up to about 21,500, and 431,239 units of electrical energy have been supplied, as against 388,422 units supplied in 1893. During the past year 2,327 yards of main and branch piping have been laid, together with 7,657 yards of main and branch cable. The condensing plant referred to in last year's report is now constantly at work, and the large saving effected in the cost of fuel and water has more than justified the amount spent upon its erection. The gross earnings during the year amount to £3,792. 11s. 8d., and after paying interest and making provision for depreciation, and writing off £200 from formation expenses, your directors are able to recommend a dividend at the rate of 3½ per cent. for the half-year ending December 31 (less income tax), which, together with the interim dividend paid in July last, makes the dividend 6 per cent. for the year. Colonel W. M. Angus and Mr. John B. Simpson retire by rotation, but are eligible, and offer themselves, for re-election as directors. The auditors, Messrs. Strachan and Co., also offer themselves for re-election.

Dr. BALANCE-SHEET, DEC. 31, 1894.		£	s.	d.
Capital—5,000 shares at £10		50,000	0	0
4,995 shares, £8 called up		39,960	0	0
Debentures		8,900	0	0
Loans	£700 0 0			
Creditors	685 0 1			
Bankers	1,837 8 10			
		3,222	8	11
Reserve fund as per last balance-sheet	650 0 0			
Add premium on new shares	58 0 0			
		708	0	0
Profit and loss account—profit for year ending Dec. 31, 1894	2,352 15 3			
Deduct balance from last year	1 4 7			
	2,351 10 8			
Less interim dividend	839 6 6			
		1,512	4	2
		£54,302	13	1

Cr.	£	s.	d.
Buildings and plant, pipes and cables (including cost of laying), meters and transformers, electrical instruments, etc.:—amount expended to date	51,624	14	10
Less depreciation fund	2,270	0	0
	49,354	14	10
Office furniture	152	15	10
Stock of stores, etc.	207	19	7
Cost of license, provisional order, etc.	581	16	10
Formation expenses as per last balance-sheet, £700; less amount written off, £200	500	0	0
Debtors (less reserve for discounts)	3,472	10	9
Cash in hand	32	15	3
	£54,302	13	1

PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1894.

Dr.	£	s.	d.
Wages, salaries, rent, rates, taxes, and directors' fees	2,316	15	6
Stores, fuel, water, etc.	1,638	18	1
Repairs and renewals	286	11	8
Stationery and general expenses	170	12	6
Balance carried down	3,792	11	8
	£8,205	9	5

	£	s.	d.
Interest on debentures and loans, £42b. 5s. 11d.; and interest on bank overdraft, £67. 10s. 6d.	519	16	5
Written off formation expenses	200	0	0
Transferred to depreciation fund	720	0	0
Balance carried to balance-sheet	2,352	15	3
	£3,792	11	8

Cr.	£	s.	d.
Electric energy supplied, less discounts	7,788	15	2
Meter and transformer rent	414	11	9
Transfer fees	2	2	6
	£8,205	9	5
By balance brought down	£3,792	11	8
	£3,792	11	8

CITY OF BATH ELECTRIC LIGHTING AND ENGINEERING COMPANY, LIMITED.

Directors: T. O. Callender, London, chairman; Alfred Pitman, Bath; B. H. Van Tromp, London; C. J. Wharton, London; J. B. Wood, London; Ernest Pitman, Bath. Secretary: Wm. Jeffery, 2, Northumberland-buildings, Bath. Engineer and manager: G. F. Metzger, A.I.E.E.

Report of the directors to be presented at the fourth annual general meeting of the Company, to be held at the works of the Company, Dorchester-street, Bath, on Wednesday, February 13, 1895, at 2.30 p.m.

In submitting the accounts for the year 1894, your directors think there is every reason for satisfaction in the improved position

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of the Company's affairs. The profit on the year's working, after charging all repairs to plant, mains, and machinery to revenue, is £702. 8s. 7d., which compares very favourably with the loss of £306. 15s. 11d. made in 1892, and the profit of £188. 1s. 4d. made in 1893. Your directors have thought it right to clear from the books all long outstanding debts, and believe that ample provision has been made for every possible contingency. The items bad debts £49. 16s. 4d. and the balance £89. 11s. 6d. at the debit of profit and loss from the past year, have reduced the available balance to £563. 0s. 9d., which would have sufficed to pay a small dividend. After consideration, however, it has been deemed best in the interests of the Company to carry this balance forward. Considerable sums have been spent on maintaining everything in first-class working order, and this expenditure has been charged against the current year's revenue. It will be noticed that a large amount has been expended during the year on capital account. A new engine has been purchased for the public lighting plant, and the dynamos for that service have been entirely rearranged. New switchboards for the private incandescent services have been erected, and some of the furnaces have been fitted to burn oil fuel. Additional transformers and meters, etc., have been purchased and service lines laid down. The directors have every reason to be satisfied with the expenditure, the good results of which will be more clearly shown in next year's balance-sheet. It is anticipated that by Christmas the existing station plant will be fully loaded, and in this event there is no doubt that the accounts will show most excellent results, and that the Company will be in a very satisfactory financial position. The confidence of the citizens of Bath in the Company is shown in the most satisfactory increase in the number of lamps connected with the mains. During the last three months these have equalled 653 8-c.p. lamps, so that at the end of the year there were 8,327 lamps wired, a very large proportion of which are in use at one time. The plant is sufficient for the supply of current to 10,000 lamps, allowing one spare set of machinery complete; the Company therefore can safely add 1,673 lamps without any further expenditure. The shareholders have every reason to be satisfied with the working of the Company during the late disastrous floods. For four days the public were depending on this Company solely for the supply of artificial light, and your directors believe that the signal success attending their operations during that period will not be forgotten by the inhabitants. The Board desire to put on record their appreciation of the energy of their manager, and of the cordial assistance given him by his staff during this trying time. The plant, machinery, and mains are in excellent condition, and at no period of the Company's history have they ever been in so thoroughly efficient and satisfactory a state. Your directors are of the opinion that the efficiency of the station and its economical working can be still further secured by a moderate additional expenditure of capital. This expenditure will probably be made early this summer, and there will be no difficulty in raising whatever money is necessary for it. In accordance with the policy settled at the special meeting of the shareholders held on September 13, 1894, application was duly made to the Board of Trade for a provisional order in substitution of the license now held, and the consent of the local authority was applied for, but withheld. A meeting of the Town Council was summoned at the last moment and held on January 14, at which it was resolved to oppose our application, and a resolution was passed that the Corporation themselves apply for a provisional order for the district in question. The interests of the Company will be well looked after by E. B. Titley, Esq., with whom will be associated, as parliamentary agent, Sydney Morse, Esq., the most experienced adviser in questions relating to the Electric Lighting Acts. The directors have full confidence in the fairness and justice of the Board of Trade, and as the matter is now in their hands it is unnecessary to discuss it. The directors having waived all remuneration during the past two years, propose to appropriate out of the profits the sum of £175 as directors' fees for the year 1894. Mr. T. O. Callender and Mr. C. J. Wharton are the directors who retire by rotation, and, being eligible, they offer themselves for re-election.

Dr. BALANCE-SHEET, DEC. 31, 1894.	£	s.	d.
Share capital—3,384 ordinary shares of £10 each ...	33,840	0	0
50 deferred founders' shares of £100 each	5,000	0	0
Mortgages and debentures	5,700	0	0
Creditors—bankers*, £3,342. 11s. 8d.; other creditors, £953. 3s. 1d.	4,295	14	9
Profit and loss account—profit this year, £702. 8s. 7d.; less balance loss to Dec. 31, 1893, £89. 11s. 6d.; bad debts, 1893, written off, £49. 16s. 4d.	563	0	9
	£49,398	15	6

* As security for this overdraft, debentures over the Company's property have been issued to and lodged with the bankers, and these are in addition to the £5,700 mentioned above.

Cr.	£	s.	d.
Property—capital expenditure on works, plant, mains, construction, and sundries to Dec. 31, 1893	38,774	4	5
Additions this year..	2,313	5	2
	41,087	9	7
Goodwill	5 000	0	0
Debtors for current supplied and installations.....	2,452	5	7
Stock-in-trade	854	18	6
Cash in hand.....	4	1	10
	£49,398	15	6

PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1894.

Dr.	£	s.	d.
Working expenses, including repairs and renewals of plant and machinery.....	3,254	12	0
Standing charges—salaries of secretary, engineer, electricians, and other officers, £617. 17s. 7d; bank charges, £117. 9s. 1d.; mortgage and debenture interest, £260. 8s. 6d.; rent, rates, and taxes, £197. 10s. 2d.	1,193	5	4
Balance, being profit	702	8	7
	£5,150	5	11

Cr.	£	s.	d.
Proceeds of sale of current and installations	5,018	8	10
Sundry receipts	49	7	3
Stock—increased value	82	9	10
	£5,150	5	11

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Madrid.—The General Directors of Posts and Telegraphs invite tenders by 19th inst. for 1,000,000 rolls of telegraph paper.

Maidstone.—The Urban District Council are open to receive offers for the transfer of their electric light order. Application should be made to the town clerk.

Hampstead, N.W.—The Vestry of St. John, Hampstead, invite tenders by the 14th inst for the supply of lubricating oil, tools, implements, and other electrical engineers' stores, carbons, and lamps. Further particulars may be obtained of the surveyor, at the Vestry Hall, Hampstead.

Weybridge.—The Urban District Council invite tenders for the public lighting of Weybridge on and after September 29. Tenders should state the number of public lights proposed, the illuminating power, and price per light. Tenders should be sent to Mr. Geo. Wheeler, clerk pro tem. to the Council, before 20th inst.

Islington.—Tenders are invited for the supply of alternate-current meters and converters by the Vestry of St. Mary, Islington. Specifications and full particulars may be obtained on application to the electrical engineer, 50, Eden-grove, Holloway, N., on or after 13th inst. Applicants will be required to deposit the sum of £1. 1s., which will be returned on receipt of a *bond fide* tender.

West Ham.—The Town Council invite tenders for a technical institute and public library in Romford-road, and invite designs for the same. Premiums of £250 £150, and £100 respectively will be paid to the authors of the designs which are placed by the assessor first, second, and third in point of merit. Particulars can be obtained on application to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham. on payment of a deposit of £1. 1s., which is returnable. Designs by May 1.

RESULTS OF TENDERS.

Bristol.—The tender of Messrs. F. W. Ball and Co., Unity-street, has been accepted by the Corporation for the installation of the electric light at the Guildhall and a portion of the Council House. The amount was £438. There were 17 tenders.

Nelson.—The tender of Messrs. Spagnoletti and Crookes, St. James's Hall, Burnley, has been accepted for lighting Stanley-street Chapel, Nelson, with electricity There also tendered: D. and G. Graham, Glasgow; Berry and Pope, Burnley; Fletcher, Hirst, and Co., Burnley; S. J. Waring and Sons, Manchester; E. Scott and Mountain, Newcastle; J. H. Ward and Co., Manchester; Maunsell, Mercier, and Co, Manchester; Briscoe and Shaw, Blackburn; Manchester Edison-Swan Company, Manchester; Nelson Electrical Engineering Company, Nelson; Calvert and Co., Manchester; Bennett and Druce, Preston; J. Hargreaves, Nelson; Coates Bros., Nelson.

London, N.W.—The Metropolitan Asylums Board have accepted the tender of Messrs. Vaughan and Brown, of Kirby-street, E.C., to provide and lay mains, wires, etc., in connection with the lighting of the North-Western Hospital by electricity, in accordance with the plans and specification prepared by Prof. Ayrton, the consulting engineer. The following is a list of the tenders received:

H. Thorpe and Waring, Theobald's-road, W.C.	£1,180	10	0
Vaughan and Brown, Kirby-street, E.C.	1,239	0	0
J. Sax and Co., Limited, Ridgmont-street, W.C.	1,335	0	0
Paterson and Cooper, Dalston, N.E.	1,355	0	0
Graham and Biddle, Oxford street, W.	1 392	10	0
Roger Dawson, Limited, Berners-street, W.	1,450	0	0
Fowler, Lancaster, and Co., Limited, Birmingham.....	1,467	19	6
Gilbert and Co., Kensington, W	1,567	0	0
Strode and Co., Regent's Park, N.W.	1,827	0	0
Brush Electrical Engineering Company, Queen Victoria-street, E.C.	1,900	0	0
T. Potter and Sons, Limited, Oxford-street, W.	2,198	0	0
Crompton and Co., Limited, Lillie-road, S.W.....	2,575	0	0
F. A. Glover and Co., Queen Victoria-street, E.C.	2,667	18	0

The committee state that the amounts above quoted are not the exact sums for which each firm offer to do the work. Each tender is made up of the above-mentioned figures and a short schedule

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of prices. The tenders were so obtained on the advice of the consulting engineer, but it is not anticipated that the cost of the work will much exceed the amounts above quoted. Prof. Ayrton's estimate for the whole work was £2,116, but this figure includes about £900 for the laying of some of the mains which the Vestry of Hampstead have now undertaken to do, and for wiring buildings not yet erected. The cost of the whole work under the tender now recommended will not exceed the estimate as above qualified.

Newport.—Tenders have been received by the Museum Committee from the following for wiring and fitting the new museum buildings:

Allam and Co., Cardiff	£46	10	0
W. A. Baker and Co., Newport	74	0	0
Arnold and Co., Newport	80	0	0
Alger and Son, Newport	83	10	0
Davis and Son, Derby	88	0	0
Newport Electric Lighting Company	93	0	0
Hatcher and Co., Cardiff	95	0	0
Fergus and Co., Cardiff	141	5	0

The first-mentioned tender has been accepted by the committee, the stipulation being made that the firm shall guarantee to carry out the work to the Town Council's satisfaction, and to comply with the fire insurance company's requirements.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,279.

Great Northern Telegraph Company.—For the month of January the receipts were £23,200.

Dundalk.—The Town Commissioners have instructed the surveyor to prepare a report on electric lighting with the use of water power.

Maidstone.—The report of the Electric Lighting Committee will be brought forward at the next meeting of the Urban District Council.

Cuba Submarine Telegraph Company.—For the month of January the receipts were £67 more than for the corresponding period of 1894.

Eastern Telegraph Company.—The receipts for the month of January were £70,674, as against £64,851 for the corresponding period of 1894.

Direct Spanish Telegraph Company.—For the month of January the receipts were £1,878, as against £1,909 for the same period of 1894.

Blackrock.—The Town Commissioners of Blackrock (Ireland) have decided to let the question of electric lighting remain in abeyance for the present.

Telegraph Construction and Maintenance Company.—The Board recommends a balance dividend of 15 per cent., making 20 per cent. for the year 1894.

Eastern Extension Telegraph Company.—For the month of January the receipts show an increase of £1,638 as compared with the corresponding period of 1894.

Fermoy.—The Town Commissioners will shortly consider the report prepared by Mr. T. Tomlinson, who suggests the use of water power in conjunction with gas-engines.

Office-Lighting.—The North-Eastern Railway Company have entrusted to Messrs. Drake and Gorham the work of lighting their new offices in Great George-street by electricity.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 3rd inst. amounted to £924, as compared with £632 in the corresponding week of last year.

Medical Electrical Institute.—Mr. Justice North has made an order for an interim appointment of a receiver or manager in the case of Ross *v.* the Medical Electrical Institute, Limited.

Priestman Bros. Limited.—A supervision order has been made in the case of this Company. Mr. Eve, Mr. Sheldon, Mr. C. Macnaghten, Mr. Nepean, and Mr. Pike Glasgow were the counsel engaged.

Stage-Lighting.—A meeting of the shareholders of the Pavilion Music Hall was held on Monday, at which the Chairman stated that there had been additional outlay occasioned by the installation of the electric light on the stage.

Business Change.—Messrs. King, Mendham, and Co., of Narrow Wine-street and Fairfax-street, Bristol, inform us that they have closed their London agency, and that all communications should now be sent direct to Bristol.

Portsmouth.—The Town Hall Committee have recommended the Council to accept an offer of £200 for the machinery formerly used for electric lighting purposes at the Town Hall. The plant was purchased about six years ago at a cost of £1,970.

Personal.—Mr. A. S. Blackman is at present in charge of the Aberdeen Corporation electric light station. He intends applying for the post rendered vacant by the resignation of Mr. E. T. Ruthven Murray, who is going to the Worcester station.

St Luke's.—The Vestry have unanimously decided to support the Vestry of St. George-the-Martyr, Southwark, in their appeal to the Board of Trade against allowing the construction of electrical transformer-chambers in the main thoroughfares of the Metropolis.

Penarth.—A fire, which resulted in the total destruction of the electric lighting plant at the Penarth Dock, occurred on Wednesday. The plant belonged to Messrs. J. B. Saunders and Co., Bute Docks, Cardiff.

Water Power.—"Power," care of Messrs. Deacon and Co, of 154, Leadenhall-street, E.C., advertises that he has available water power for electrolytic and other manufacturing processes, to the extent of many thousand horse-power, at 16s. per horse-power per annum.

Change of Address.—Messrs. Howard B. Little and Co., of 20, Eldon-road, Kensington, W., inform us that all communications and enquiries should now be directed to 36, Shaftesbury-avenue, W. The company are now making a feature of the winding of induction coils and transformers, so as to meet special requirements.

City and South London Railway.—The receipts of the Company for the week ended February 3 were £1,021, against £951 for the corresponding week of 1894, or an increase of £70. The total receipts for the current period of the present half-year are £5,020, against £4,790 in the corresponding period of 1894, an increase of £230.

Sunderland.—The Town Hall Committee have held a meeting at which the principal business was the consideration of the estimates for the year ending March 1896. The estimated expenditure was put down at £1,470. 7s. 10d., the principal item being £450, the cost of the installation of the electric light and alterations to gas fittings.

Belfast.—A meeting has been held of the Town Council at which Alderman Pirrie moved the adoption of the report of the Electric Light Committee, which set forth that the central station had been sufficiently completed to enable them to supply current, and the installation had been inaugurated on the 23rd ult. The report was accepted.

Dublin.—The Dublin United Tramways Company have received the sanction of the Privy Council for the extension of their system to Dolphin's Barn, the doubling of the North Circular road line, the laying down of an interlacing double line in South Great George's-street, and the formation of a junction at Merrion-square for traffic with Rathmines.

Transfer of Business.—Messrs. E. P. Allam and Co., of 49, Finsbury-pavement, London, E.C., inform us that they have purchased the electrical engineering business lately carried on by Mr. D. F. Adamson at 72, Finsbury-pavement, E C, and that it will be continued at the former address. The company also have offices at 16, Albert-chambers, Cardiff.

New-Mayne Electric Rudder Motor Syndicate, Limited.—This Company has been registered, with a capital of £20,000, to acquire and turn to account the English patent and one moiety of the foreign patents to be taken out, if considered advisable, of Messrs. New and Mayne's invention for an electric rudder motor, which is covered in Great Britain by letters patent.

Partnership.—Mr. A. T. Salisbury-Jones, of 33, Old Broad-street, informs us that, in consequence of the increase in his business during the last few years, he has now taken into partnership Mr. Guy L. Bidwell, who has been connected with him in various transactions for some years past. The business will be continued under the style of Messrs. Salisbury-Jones and Bidwell.

Peterborough.—The Town Council have appointed the Mayor, Alderman Barrett, and Councillors Clifton, Nichols, and Simpson, a deputation to wait upon Mr. G. C. W. Fitzwilliam with regard to the use of a piece of land on the west side of the cattle market, as a central station for the supply of the electric light in the city, or to ascertain if an alternative site could be obtained.

Catalogue.—There has been issued by Messrs. Hayward Tyler and Co., of 90 and 92, Whitecross-street, London, E.C., a catalogue of electrical plant, which contains some details concerning the methods of electric lighting, and also illustrates direct and alternating current dynamos, high-speed vertical engines, mine pumps, portable electric lighting plants, accumulators, measuring instruments, fittings, lamps, boilers, gas-engines, etc.

Trade Note.—Messrs. W. T. Glover and Co., electric wire and cable makers, of Salford and London, have arranged for Mr. Walter Blenkarn to represent them in the western, southern, and eastern counties of England. Mr. Hartford, who has hitherto represented them, still continues with the firm, and will take the northern counties. This addition to the staff has been rendered necessary by the rapid increase in the company's business.

Eton.—A meeting of the Eton Urban District Council has been held at the Board-room, Barnes Pool Bridge, to consider and decide as to giving consent to the provisional order which it is proposed by the Windsor Corporation to obtain for the purpose of supplying electric light in the district, Eton being a portion of the proposed area of supply. The chairman, Mr. E. C. Austen-Leigh, presided. After a lengthy discussion it was agreed that the consent be given.

Hargreaves and Shaw, Limited.—This Company has been registered, with a capital of £5,000, to acquire and take over as a going concern the business of electricians and mechanical engineers now carried on by Ellis Hargreaves and Ellis J. Hargreaves, as Hargreaves and Co., at Atlas Works, Curzon-road, Ashton-under-Lyne, and to enter into an agreement with the vendors for the purpose and to carry on the business of an electric light company.

Ibo Syndicate, Limited.—This Company has been registered, with a capital of £50,000, to construct, execute, carry out, equip, improve, work, develop, administer, manage, or control, in Africa or elsewhere, public works and conveniences of all kinds, rail and tramways, docks, harbours, piers, wharves, canals, reservoirs, embankments, irrigations, water, gas, electric light, telephonic,

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telegraphic, and power supply works, and hotels, warehouses, markets, etc.

Stafford.—With regard to the charge for electricity, Alderman Peach at Tuesday's meeting of the Town Council said that the committee had decided to recommend the Brighton system, in which the charge was 8d. per Board of Trade unit for the maximum hours in which the electricity was used, and 4d. per unit after this maximum had been passed. This, he contended, would put the small consumers on the same footing as the large ones The report was adopted.

Tunbridge Wells.—A meeting of the Town Council was held on Wednesday, when, in reply to questions by Councillor Jenkinson as to the cause of alleged electric light explosions in London and elsewhere, the Mayor said he could reassure them as regarded Tunbridge Wells, as there was no likelihood of such explosions in the streets. The mains were not laid down in Tunbridge Wells as they were in London. Even as regarded London explosions, it had been shown that they were due to gas.

Oldham.—A meeting of the Town Council was held on Wednesday, when Alderman Emmott asked that a balance-sheet should be issued with regard to the working of the electric light. Alderman Smith (chairman of the Electric Lighting Committee) said that a balance-sheet would have been issued before now, but certain of the machines were unsatisfactory, and until such time as the engineer would pass them nothing could be done in the way of placing a balance-sheet before the Council.

Llanelly.—The Llanelly Town Council held a meeting on Monday, at which the question of electric light came up on a recommendation from the Estate Committee that tenders be invited for lighting the Town Hall, Athenæum, Market Hall, and other public buildings, as well as a portion of the town, by electricity. After a discussion, eight members voted for and eight against the adoption of the recommendation. The chairman gave his vote in favour, and the minute was adopted.

Hastings.—A meeting of the Town Council was held on Friday last, at which, on the consideration of a bill of £323 for lighting the front line by electricity, Councillor Hutchings suggested that the electric light company should be asked to reduce the charge, on the ground, as he alleged, that the lighting was a failure. He moved that the matter be referred back to the committee. Alderman Bradnam seconded, observing that the lighting was not altogether satisfactory, and the motion was adopted.

St. James's and Pall Mall Company.—The transfer books of the ordinary and preference shares of this Company will be closed until the 18th inst., preparatory to the payment of dividends for the half-year ended December 31 on the ordinary and preference shares. Mr. F. J. Walker, the general manager and secretary, informs us that the number of units sold to customers during 1894 was 1,569,884, and that 60,037 8-c.p. lamps were connected to the mains at the end of 1893, as compared with 75,217 8-c.p. lamps at the close of 1894.

Copper.—Supplies of copper came forward faster in the second half of January than in the first, and deliveries did not keep pace with the arrivals. The American shipments again show a decided disposition to grow, nearly 1,000 tons more coming to Europe in January than in December. But for this increase stocks would have shown a diminution; as it is, they are 184 tons larger than on December 31, and 781 tons greater than on January 15, and prices are consequently weaker. The visible supply is now larger than at any date since March, 1893.

Eastbourne.—On Monday, at a meeting of the Town Council, Councillor Duke referred to the explosion in Terminus-road, and was about to explain the circumstances under which it occurred, with a view to showing that the electric lighting company did not contribute to the accident, when he was interrupted by Councillor MacQueen, who pointed out that this matter had been referred to the Board of Trade, and that possibly an enquiry might be held by them. He asked, therefore, if it was not out of place then to go into the matter. After some slight discussion the matter dropped.

Aberdeen.—A statement was submitted to the Town Council on Monday, showing the income and expenditure in connection with the electric lighting undertaking for the 10 months ending December. The capital account brought out a balance at debit of £619, and the net revenue account a debit balance of £217. It was decided that the price of current for the present quarter should be fixed at 6d. per Board of Trade unit. It was reported that the offer of Messrs. New and Mayne to instal a system of electric lighting in the municipal buildings for £203. 18s. had been accepted.

Derby.—The report of the Electric Lighting Committee of the Town Council stated that 100 meters had been ordered. A contract for coal had been let to Messrs. F. and H. R Johnson. Messrs. Siemens and Co. had made a constructional alteration in the arc lamps. Five transformers had been ordered. The committee hoped to submit a full report as to the settlement of the contractors' account at the March meeting of the Council. The accounts had been delayed owing to the illness of one of Messrs. Siemens's staff. The report was adopted on the proposition of Alderman Marsden.

Aberdeen.—A meeting of the Gas Committee of Aberdeen Town Council has been held, when Mr. Cran, city chamberlain, submitted a report in reference to the electric lighting department, which showed that up to date £1,850 4s. had been paid for current, and that, after allowing for interest and depreciation, a reduction had been made in connection with the deficit at the date of the last balance. In view of this fact, the committee were of opinion that it would be advisable to recommend a reduction in the price of the current for the present quarter of 1d. per unit, making the price 6d. per unit.

Mansion-Lighting.—A complete electric light installation has been fitted up in Elveden Hall, Norfolk, which was recently purchased by Lord Iveagh. The installation comprises some 500 incandescent lamps, two sets of steam-engines and dynamos, and a double battery of accumulators. Electric power is transmitted some distance for working a pump for supplying the house with water. Messrs Edmundsons, Limited, were the contractors, and the work was carried out to the specification and under the superintendence of Mr. A. A. C. Swinton as consulting engineer.

Proposed Welsh Electric Tramway.—Several engineers on Saturday inspected the ground from Colwyn Bay to Conway, and from Conway through Deganway to Llandudno. It is proposed to lay an electric tramway along the above-mentioned route. If the Llandudno District Council will grant their permission for the tramway to go along Mostyn-street and Mostyn-street extension to Craigside (the eastern end of the town), the work of laying down the Deganway portion will be at once commenced, and the survey of the whole line will be gone on with and a provisional order will be applied for in the present session of Parliament.

Worcester.—A meeting of the Town Council was held on Tuesday, when Mr. Williamson said the total loss on the electric lighting works for the first quarter was less than £100, and he held out strong hopes that by next winter the scheme would be bringing in a profit. He further stated that the builder's extras in the erection of the generation station amounted to between £4,000 and £5,000. The committee regarded that as very unsatisfactory, and they proposed to enquire into the matter exhaustively and see what extra work had been done and by whose authority. The Council asked the committee to report fully upon the matter.

National Telephone Company, Limited.—The report of the Company for the half-year ended December 31 states that the income accrued in respect of the business of the half-year amounts to £378,789, an increase of £40,861; and the expenses amounted to £205,192, an increase of £41,339. The net result (after deducting the Post Office royalties, amounting to £34,953) is a profit balance of £138,642, as compared with £142,589. The directors recommend a dividend at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the third preference and ordinary shares; they also propose to transfer £35,000 to the reserve fund, and to carry forward £3,379.

Kendal.—A meeting of the Town Council has been held at which Councillor Littlewood said the circular that had been sent out, enquiring if burgesses would become customers for the electric light, was not remarkable for its perspicuity. It did not afford any reliable information to go upon. To say that the cost would be 7d. or 8d. per Board of Trade unit, which was equal to gas at about 5s. per 1,000 cubic feet, was very vague. After wandering on in this style for some time, a desultory and foolish conversation ensued, which led to nothing. The Rural District Council of South Westmoreland have heard a statement from a representative of the electric light company, but have deferred consideration of the matter.

Bolton.—The Gas and Electricity Committee of the Corporation have abolished the differential scale of charges for the supply of electricity, and have introduced a uniform rate of 6d. per Board of Trade unit. Mr. John H. Rider, the borough electrical engineer, states that at this rate the net price, with a discount of 10 per cent., will work out at 5·4d. per unit. It is proposed to borrow £18,000 for an extension of the electric lighting. The Finance Committee of the Town Council have considered the question of lighting the offices in the Town Hall by electricity. It was resolved to recommend that estimates be obtained for lighting the Albert Hall and the offices in the Town Hall, with the exception of the waterworks offices, by electricity.

Appointments.—The Hyde Technical Instruction Committee require the services of a competent person to act as organising and general secretary, at a salary of £200 per annum, who will be required to enter upon his duties in May next, and to devote his whole time to the work of the committee and its sub committees. Applications, stating age and qualifications, together with copies of three recent testimonials, and enclosed in an envelope endorsed "Secretary," to be forwarded to the town clerk, Hyde, so that the same may be received by him on or before March 9. A full statement of the duties and form of application will be supplied by Mr Geo Stevens, town clerk.—The Gas and Electricity Committee of Salford require two switchboard attendants. Particulars are given in our advertisement columns.

Queenstown.—A meeting of the Town Commissioners has been held, at which Mr. Long proposed a resolution, "That a competent electrical engineer be employed, at a sum to be agreed upon, to report to the Board the practicability of lighting Queenstown by electricity by the present machinery at the pumping station, and the probable cost of same." He said they had offers from electrical firms that they were prepared to give the Commissioners every advice on the matter, and when they had got all the information on the subject they could adopt it or not. He would suggest that when the business was over, their monthly meeting should stand adjourned until Mr. Hammond, electrical engineer, who had offered to give them information on the subject, would be present. Mr. Campbell seconded the motion, which was agreed to.

Wigan.—A meeting of the Gas Committee of the Town Council has been held, at which the report of the Electric Lighting Sub-Committee on schemes and tenders submitted by various firms was read, and it was resolved that the report be printed and circulated

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to the members of the Council, and that the tender of Messrs. John Fowler and Co. be accepted subject to the sanction of the Local Government Board being obtained for the borrowing of the money necessary for the purpose on the understanding that the work is not to be commenced and no liability incurred until such sanction is obtained. The Council was recommended to apply to the Local Government Board for power to borrow £20,000 for carrying out the scheme, and the gas engineer was instructed to prepare the necessary plans. The chairman, vice chairman, and Messrs. Richards, Johnson, Rigby, and Smith were appointed a sub-committee to supervise the work.

Newhaven.—The Board of Trade have forwarded to the Urban District Council a copy of Section 4 of the Electric Lighting Act, 1888, and requested the Council to inform the Department whether there were any electric lines or works such as were contemplated by the section within the district The Chairman stated that the information sought for in the communication could be readily supplied by Mr. Knightley, who would report that there were certain lines laid down for the supply of electric light. Of course he referred to the company's system. The object of the Board of Trade was that where such lines existed they should be so laid as not to interfere with the public service of telegraphs either directly or indirectly. The local authority was made responsible for informing the central department of any such lines being laid, so that the Board of Trade might take the necessary steps to protect the telegraph lines and other things connected with the postal service.

The Proposed Acton Electric Tramway.—In our last issue we recorded the adverse decision of the London County Council in this matter. It has also been before the Middlesex County Council. Their Parliamentary Committee reported in reference to the London United Tramways provisional order that it proposed to authorise the promoters, with the consent of the Board of Trade, to work the tramways by means of electrical or other mechanical power. As they were advised that this would enable the promoters to use steam power, to which the Council had strongly objected in the case of the North London tramways, and as the Council had not been asked to consent to the order, the Parliamentary Committee had directed the county solicitor to take the necessary steps for the lodging with the Board of Trade of a petition against the scheme. The committee recommended the Council to approve their action in the matter, and to empower them to take such steps as they might consider necessary to protect the interests of the county. The Council adopted the recommendation.

Eccles —On Monday, Mr. Alderman Kendall, at a meeting of the Town Council, moved the adoption of the report of the Town Hall, Tramways, and Electric Lighting Committee, which stated that "having carefully considered the question of the advisability or otherwise of carrying out the powers conferred by the Eccles Electric Lighting Order, 1893, upon the Council, and the information and advice which they have received on the subject, the committee are of opinion that the time has arrived when the Council may safely proceed with a scheme for electric lighting in the borough." Mr. Kendall remarked that at present it cost between £1,200 and £1,400 a year to light the streets of the borough with gas, which meant a rate of about 3½d. in the pound. An eminent authority who had been consulted said that the streets could be lit for about £780, or that at any rate a saving of something like £300 a year in the cost of street-lighting would follow the adoption of electricity. Many other towns were adopting the electric light, and he thought Eccles should follow their example. The adoption of the minutes was carried after some discussion.

Cardiff.—A meeting of the Lighting and Electrical Committee of the Cardiff Corporation was held on Tuesday afternoon. The committee first visited the electric light station, and afterwards assembled in the borough engineer's office. The Mayor said that Messrs. Siemens and Co. had signified their intention of handing over the work complete to the Corporation in about three weeks' or a month's time, and in consequence of this they had to consider the question of discontinuing the lighting of the town by gas. Alderman Jacobs asked what had been the cause of the great delay, and Mr. Massey, the electrical engineer, explained that it was in consequence of Messrs. Siemens wanting to give more perfect lighting at the same cost and to give complete satisfaction to themselves. Some discussion ensued, in which the Mayor stated that it was the intention of the Corporation to run the engines both day and night. Mr. Harpur asked to be relieved of the responsibility of looking after the station at Canton. It was resolved that a sub-committee be instructed to approach Mr. Franklyn (in Messrs Siemens's employ at Cardiff) with the object of securing his services at a salary of £200 a year.

Cheltenham.—The borough surveyor having reported progress to the Electric Lighting Committee of the Town Council, he mentioned at a meeting of the Town Council last week that for executing current repairs a 6in. lathe should be obtained, the cost of which would be £35. With regard to the claims for compensation arising out of street accidents caused by the electric lighting works, it was resolved to settle with Mr. Muller, and to allow the town clerk and borough surveyor to see Mr. Millns on the accident alleged to have befallen him. Mr. R. E. Steel, solicitor, wrote claiming £20 compensation on behalf of Mrs. M. A. Wickham, of Southampton Villa, High-street, for injuries sustained by her having fallen over some planks on the footpath at the High-street corner of the Bath-road. It was resolved that the town clerk should enquire into the matter and report to the next meeting. A representation of the Public Library Committee that this committee should supply the electric light to the library free of cost was considered; but it was resolved that the committee could not recommend a free supply, but would light the library for £50 per annum (the charge for gas last year having been £57. 18s.), the public library to undertake to do their own wiring.

Trowbridge.—The Urban District Council have held a meeting at which the clerk read a letter from Mr. Medhurst, offering himself as an expert to the Council before they made application to the Board of Trade for a provisional order for electric lighting, because it was, he said, most essential that an order, to be of value commercially, should contain the best and most suitable definition of compulsory and permissible areas. He suggested that he should be allowed to instruct one of his assistants to make a thorough house-to-house canvass in the most important streets of their town, and that afterwards he should report to the Council on the whole electric lighting question, such report to contain recommendations as to compulsory and permissible areas and site for generating station. His fee for preparing an exhaustive report and plans for the house-to-house inspection referred to would be 40 guineas, exclusive of out-of-pocket expenses. The Chairman said the General Purposes Committee had the letter read to them, but they did not make any remark upon it. Since then their surveyor had received another letter. This was from Messrs. Casper and Lion, of London, who said they intended to tender for the lighting supply of the town. and asked the surveyor to furnish them with certain particulars. Both matters were allowed to drop.

Leeds Tramways.—As mentioned in our last issue, a further meeting of the Leeds Tramways Committee was held on Monday, when the haulage question again came up for consideration. The city engineer, Mr. Hewson, in accordance with instructions, presented a report on the cost of constructing and working an electric conduit system in the centre of the town. The committee resolved to recommend the adoption of this report. The proposal is that this system should be in use from Boar-lane, along Briggate and New Briggate, to the dispensary; from Boar-lane, in another direction, to the junction of Hunslet-lane with Hunslet New-road; from Briggate, along Wellington-street as far as Queen-street; and from Boar-lane, on the Headingley section, as far as the Bank of England, in Park-row. For the other parts of the city the committee recommend the Council to adopt the overhead system. The members are of opinion that the pillars and wires that would be required for the working of the overhead system in Briggate, Boar-lane, and the other central thoroughfares mentioned, would be an inconvenience, and they believe that the two systems—the conduit for the centre of the city, and the overhead for outside—can well be worked together. The actual capital cost per mile of the overhead electric system is said to be about £10,500, and of the conduit system about £14,500 The report of the Tramways Committee to the full Highways Committee has not yet been drafted, but at Monday's meeting four members were constituted into a special sub-committee for this purpose.

Birmingham —The Town Council met on Tuesday, when Mr. Martineau, in connection with the matter of the new technical school, moved that the committee be authorised to purchase additional apparatus and appliances at a further cost of £4,000; to expend £14,000 in providing the fittings for the new technical school, and removing machinery, etc., from the present temporary premises; £6,080 in providing electric lighting and fittings and motive power; and £3,340 in architect's and electrical engineer's commissions, etc.; and that the Finance Committee be instructed to borrow £27,420 for such purposes. Mr. Parkes seconded the motion. Mr. Bradley moved as an amendment that with regard to the proposed electric light installation, the committee be instructed to accept the lowest tender on the specification originally issued. He complained, that after first asking for a limited number of tenders, the committee had applied publicly for tenders, and if the resolution were passed the Council would be doing an injustice to the firms the committee invited to tender in the first instance. Mr. Bishop seconded the amendment. Alderman Pollack proposed as another amendment that that part of the report which related to the fitting and lighting of the new school, should be referred back for the purpose of enabling the committee to supply further and fuller particulars of expenditure under the various heads. Alderman Clayton said he was going to move that the consideration of the report be adjourned, and that the committee be instructed to report fuller details of the various tenders for the supply of apparatus, fittings, and electric power, and also their objection to lighting the building by gas after communication with the gas department. Ultimately Mr. Clayton's amendment was accepted.

New Swindon Junior Engineering Society.—The annual conversazione of the Swindon Junior Engineering Society took place last week, when the medals were presented by Mr. W. Dean, the president of the society. A large company was present, including Canon the Hon. M. Ponsonby, Messrs. G. J. Churchward, D. E. Marsh, W. H. Williams, E. C. Riley, and W. H. Stanier, Mr. Hooper Deacon, Mr. Douglas T. Heap, etc. Mr. Dean, in a brief address, said the society had been in existence for a couple of years. During the 1893 session five papers were read by three members, but during the next session 10 papers were read by 10 members. Messrs. Churchward, Marsh, and Williams had been asked to adjudicate upon the various papers, and they reported that the task of selecting the winners of the prizes was very difficult, as the papers were of uniform excellence. In the 1893 session Mr. A. E. Leader secured the medal, Mr. T. C. Davison receiving honourable mention; whilst in the following session Mr. H. G. Cotsworth's paper secured him the award, Mr. W. R. Bird and Mr. G. H. Burrows being especially mentioned. The collection of scientific instruments and other objects of interest were keenly examined,

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Messrs. Crompton and Co., of London, made a large display of electrical exhibits—their several uses being explained by Mr. D. T. Heap. The samples, together with the bare copper systems used in underground mains, attracted considerable attention, whilst the electrical cooking and heating apparatus proved of interest. Current indicators, voltmeters, and other instruments were displayed. Sir F. Abel's apparatus for determining the temperature at which the vapour of light mineral oils for burning, etc., becomes inflammable, Boverton Redwood's viscometer, and other articles were sent by Mr. H. W. Harris; whilst Mr. A. Nash displayed an astatic galvanometer, telephone transmitter, galvanometer, microphone, electromagnet, and kaleidoscopes, which he had constructed. An arrangement of telephones and recording apparatus, the work of Mr. E. J. Tincknell, was also shown.

Liverpool.—A meeting of the Special Lighting Committee of the Liverpool Corporation has been held, at which there was read a letter from Mr. M. F. Radcliffe, solicitor to the Liverpool Electric Supply Company; also reports of the city engineer and the deputy town clerk. It was moved by Mr. Taylor, seconded by Mr. Petrie, that the Council be recommended to consent to the application by the Liverpool Electric Supply Company, Limited, for a provisional order to carry out the arrangement made with the company at the enquiry on the proposed extension of the city boundaries, provided such order is withdrawn if the order for the extension of the city boundaries is not confirmed by Parliament in the ensuing session, and that the Council be recommended to object to the application for any other purpose. On a division there appeared for the motion three—viz., Mr. Taylor, Mr. Petrie, and Mr. Williamson—against it one—viz, the chairman. The motion was therefore carried. At Wednesday's meeting of the Town Council, Mr. Austin Taylor raised an objection to a resolution passed by the Lighting Committee that the Council should provide electric light, in competition with the electric supply company, within its own area. The committee, he said, had received from the Council powers to effect a possible and amicable arrangement for the purchase of the company's undertaking. The resolution he complained of, however, was passed before the committee had even given an intimation of their desire to open negotiations, and that course was neither straightforward nor businesslike. The deputy town clerk, knowing the policy of the Board of Trade in regard to these licenses, assured them that they had no chance of getting one, and that if they did they would have to face a serious financial obligation, because the capital had to be repaid within seven years. The case they had to put before the Board of Trade was that they were supposed to negotiate with the company in a friendly way, and at the same time they were applying for a license to compete with them. He moved that the proceedings of the committee be approved with the exception of the resolutions of the 14th and 21st January, and that the Lord Mayor be requested to countermand the summons for a special meeting of the Council on the 6th March, under the Electric Lighting Acts. Mr. Petrie seconded the amendment, which was carried.

The City.—The past year's work of the City Commission of Sewers shows that the cost of electric lighting and the alleged surreptitious laying of telephone tubes by the City of London Electric Lighting Company were among the burning questions of the year. On May 1 it was pointed out that the 479 arc lamps in use cost £12,454 a year to maintain, against £4,631 for the 1,315 gas lamps which they have replaced. Since then proposals have been considered for a cheaper system than arc lamps for the side streets, but nothing was settled during the year. The telephone tube difficulty arose in this way. When it was discovered, the previous year, that the electrical company had laid telephone tubes along with their own mains, an agreement was come to that the placing of telephone wires in the tubes should be allowed on condition that the use of the telephones should be granted to persons in the City at £8 a year, including all the latest conveniences and improvements. The New Telephone Company was to have had the use of the tubes by arrangement with the electric lighting company, but when the National Telephone Company averted the threatened competition by absorbing its rival and annexing the contract for the tubes, it refused to make use of them on any such condition as the £8 rental. In these circumstances Mr. Gordon moved on July 17 that the £8 agreement should be rescinded, and that the Commission should accept an offer of the electrical company that on consent being given to the use of the tubes they would pay 10 per cent. of all rentals received up to £10,000 and 20 per cent. on rentals in excess of that sum, the minimum payment to be £1,000 a year. There was a majority in favour of this motion, but it failed to secure the support of the two-thirds necessary in a rescinding resolution, and was accordingly lost. On July 31 Mr. Pannell moved a simple rescinding resolution as to the £8 condition, which was refused by the company, and this was carried, it being pointed out that the refusal of terms simply led to the multiplication of overhead wires. This left the ground open for further negotiations, but no fresh steps have been taken since, and the tubes apparently lie fallow pending a working agreement. The new Commission held their first meeting on Tuesday. Mr. Wallace asked what had been done by the Streets Committee in respect to the use of electric conduits for telephones, and whether the Commission was justified in refusing to accept the large revenue offered by the company for the use of the electric conduits for telephonic purposes. The Chairman said the matter was under the consideration of the Streets Committee, which would report shortly. Mr. Burmester explained that Mr. Morton considered that the present question and that of the Post Office agreement were bound up together, and so no report had yet been made to the Court, but he (the speaker) could hardly see how the two questions were so closely connected. He believed the committee would present a report on the subject at the next Court. The discussion then closed.

South Staffordshire Tramways.—Major Marindin, of the Board of Trade, has attended at the Town Hall, West Bromwich, for the purpose of holding a conference with the representatives of the various local authorities in the Black Country with reference to the use of steam on the South Staffordshire tramways. Major Marindin explained that the conference was held with reference to the extension of the license for the use of steam upon the Staffordshire tramways. Some of the authorities, he understood, objected to that extension being given. He thought it would be better to ask the tramway company what their proposals were with regard to the matter, and what length of time would be necessary for them to have to enable them to introduce some other system of traction which would be satisfactory to the local authorities. Mr. Blundstone, director, said the company were at present involved in expensive litigation, and until that was settled they were not in a position to introduce any other system of traction. He thought that in six months' time their affairs would be considerably straighter, and they might be able to introduce a new form of traction. With regard to the new form of traction, he pointed out that the cable system was the most expensive, and if it was to be laid down as far as Carter's Green from Handsworth it would be four or five years before it would pay. They had provided the public with a great convenience for many years without having a farthing profit. There might be an inconvenience through the use of steam, but unless it was dangerous he thought the local authorities might very well extend it until the tramway company was in a more flourishing and stable position. If the company cabled the line from Handsworth to Carter's Green, the rest of the line would be worked with overhead electric traction. If the extension were granted, the company would be in a position to see where they were. He estimated that the cost of cabling the line from Handsworth to Carter's Green would be about £70,000. He denied that the line worked by the overhead system of traction was under the control of the Electric Construction Corporation, although he admitted that they paid the latter about 8d. per mile, or about four-fifths of the receipts per mile. The Electric Construction Corporation owned the generating stations and cars. The present directors did not recognise the contract because they believed it was ruinous to the company. Mr. A. Dickenson, manager of the company, estimated that the cost of laying down the cable system from Handsworth to Carter's Green would be at least £70,000. He said he did not know what the intention of the present directors was, but the late directors intended to lay down a cable system from Handsworth to Carter's Green. They did not, however, know the satisfactory working of the electric system, and they assumed that it would be more costly than the cable system. At that time it was possible to make arrangements with the Birmingham Central Company to run the cars right through to Birmingham from Carter's Green, and terms were practically arranged; but internal discussion arose, and the persons who were willing to find the money would not now do so. The cost of laying down a cable system was very great, and during construction it would cause considerable inconvenience to the public. He did not think there would be any difficulty in arranging for money to equip the lines electrically, but there would be a difficulty in getting the money to lay down a cable system. If the electrical system was adopted in West Bromwich, they would require arms about 10ft. in length They could then arrange to run cars direct from Walsall and Bloxwich to West Bromwich without changing. They had no complaints from the local authorities through whose districts the electric system passed, but, on the other hand, it was approved. Not only had the line in the Walsall district given entire satisfaction, but it was worked freer from accidents than any other tramway in the kingdom. The mayors of Wednesbury and Walsall had written to him congratulating him upon the satisfactory working of the electric system. It could be worked about 3d. per mile cheaper than steam. Ultimately the inspector promised to report the matter to the Board of Trade, and afterwards inspected the line.

PROVISIONAL PATENTS, 1895.

JANUARY 28.

1915. **An electric safety alarm indicating fog-signalling apparatus for preventing accidents on railways at junctions, stations, and level crossings, and for other purposes.** A. Tylee, J. Miles, and G. F. Nightingale, 3, St. John's-place, Castle-street, Kingsland, London.

1931. **Making carbons, candles, and pencils for electric lighting and parts of electrical machines or dynamos, such as "brushes," out of plumbago, graphite, or blacklead in its natural state.** Wolf Henry Cohen, 118, Fenchurch-street, London.

1936. **Improvements in or connected with dynamos.** Jesse Graham and Harry Chapman, 33, Chancery-lane, London.

1940. **An improvement in electrical controlling switches.** Edward Hopkinson and Arthur Pemberton Wood, 28, Southampton-buildings, Chancery-lane, London.

1949. **A combined mat and electric alarum contact.** James John Pye, 27, Martin's-lane, Cannon street, London. (Complete specification.)

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1954. **Improvements in and relating to electrical devices, such as electromotors, generators, and the like, for use in explosive atmospheres.** Sidney Allingham, 1, Queen Victoria-street, London.

JANUARY 29.

1970. **A method of and apparatus for charging electrical accumulators from alternators and changing into an alternating current the current given by the accumulator cells.** Joaquin de Galindez, 46, Lincoln's-inn-fields, London.

2004. **Improvements in electric recording meters and in motors for operating same and for operating the escapement mechanism of clocks or other apparatus requiring a chronometric movement.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Charles Wirt, United States.)

2009. **Improvements in holders for electric lamps.** William McKenzie and John Ambrose Fleming, University College, Gower-street, London.

2025. **Improvements relating to combined gas and electric light standards.** Robert Walter Braham, 76, St. Agnes's-place, Kennington, London. (Complete specification.)

2031. **Improved automatic coupling for electrometers.** Siemens Bros and Co, Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.) (Complete specification.)

2064. **Improvements in automatic switches and in their use for distribution of electricity.** John Hopkinson, 5, Victoria-street, Westminster.

JANUARY 30.

2077. **Closed-conduit electric railway.** Edward James Paterson, European Works, Pownall-road, Dalston, London. (F. F. Atkinson, United States.)

2100. **Improvements in the construction and method of arrangement and connection of cables and joints for electrical distribution.** George Schults, 6, Lord-street, Liverpool.

2133. **Improvements in or relating to electric batteries.** Junius Pogneaux, 323, High Holborn, London.

2134 **Improvements in or relating to electrical signalling apparatus for preventing collisions between trains.** Alejandro Basanta y Baqué, 323, High Holborn, London. (Complete specification.)

2137. **A permanently and automatically synchronised printing telegraph.** Charles Austin Beck and Charles Rock, 106, Great Russell-street, London.

JANUARY 31.

2182. **A duplex incandescent electric lamp.** George Frederick Attree, 8, Hanover-crescent, Brighton.

2218. **Improvements in or relating to "watt-hour" counters for alternating currents of electricity.** Georg Hummel, 323, High Holborn, London.

2223. **Improvements in and connected with phonographs.** George McMurdie and Christopher Daggett, 4, South-street, Finsbury, London.

2228. **An improved combined starting, reversing, and controlling electric switch for operating electric motors.** Walter Angrove Clatworthy, 1, Queen Victoria-street, London.

2237. **Improvements in induction coils for use as resistances in electrical plant working with alternating current and with multiphase currents.** Josef Franz Bachmann, Josef Liebscher, and Adolf Vogt, 46, Lincoln's-inn-fields, London.

FEBRUARY 1.

2250. **Improvements in double and triple pole switches.** Frank H. Starling, Gresham Electrical Works, Nottingham.

2277. **Improved method and means of connecting electrical accumulator plates with their conductors.** Georg Hirschmann, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2280. **Improvements in galvanometers.** William Oliver Smith and George Keith Buller Elphinstone, 5, South-row, Blackheath, London.

2288. **Improvements in voltaic batteries.** Desmond Gerald Fitz Gerald, 53, Chancery-lane, London.

2289. **Apparatus for counting or recording telephonic conversations.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States). Complete specification.)

2303. **Improvements in and relating to apparatus for lighting and extinguishing electric lamps.** Lucien Hermand, 45, Southampton-buildings, Chancery-lane, London.

FEBRUARY 2.

2308. **Improvements in apparatus for testing magnetic quality in iron.** James Alfred Ewing, Langdale Lodge, Cambridge.

2312. **Improvements in apparatus for regulating electrical pressure.** Job Thomas Niblett, 20, Devonshire-road, Greenwich, London.

2333. **Improvements in apparatus for the use of the electric light for photographic purposes.** Andrew George Adamson, 154, St. Vincent-street, Glasgow. (Complete specification.)

2341. **Improvements in the driving of electrical or other machines on railway or other vehicles or engines.** William Henry Hallsworth, Bow Mills, Dukinfield.

2343. **Improvements in or relating to electric incandescent lamps.** Augustus Edwin Pope, 6, Lord-street, Liverpool. (Frederick Roberts Pope, Holland.)

2355. **Improvements in magnetic testing apparatus.** William Edward Ayrton and Thomas Mather, Central Technical College, Exhibition-road, London.

2366. **Improvements in electro-dynamometers.** Siemens Bros. and Co., Limited, and Edward Friedrich Heinrich Hermann Lauckert, 28, Southampton-buildings, Chancery-lane, London.

2373. **Improvements in the socket joints of metallic telegraph poles.** Bullers, Limited, and Edward John Chambers, 7, Staple-inn, London.

SPECIFICATIONS PUBLISHED.

1892.

17922. **Secondary batteries.** King and Clarke. (Second edition.)

24127. **Secondary batteries.** King. (Second edition.)

1894.

489. **Electric clocks.** Herbert.

548. **Telegraph signal receiving instruments.** Thompson. (Melhuish.)

2105. **Arc lamps.** Brown and Offord.

2806. **Electrolytical decomposing apparatus.** Kellner.

3725 **Galvanic elements.** Blackhurst.

4142. **Electrical letters and signs.** Upward.

4254. **Electric arc lamps.** Andrews.

4724. **Secondary batteries.** March.

5102. **Telephonic relay.** Gillmore.

6554. **Telegraph poles, etc.** Bullers, Limited, and Chambers.

9129. **Electrolysis.** Blumenberg.

10149. **Supporting electrical conductors, etc.** Orme.

14545. **Dynamo-electric machines, etc.** Thomas Parker, Limited, and Parker.

23553. **Electrical treatment of beer, etc.** Wagner and Marr.

23745. **Electricity meters.** Telge.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5¾
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅝-2¾
—— Nom. Cum., 6 per cent. Pref.	2	2⅝-2¾
—— 4½ Debenture Stock	100	115-118
Charing Cross and Strand	5	5-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	15½-15¾
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	48-50
—— 4 per cent. Debenture Stock	100	128-130
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	3-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	102-107
Electric Construction, Limited	2	½-¾
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1½-1⅝
Elmore's French Company	2	1/16-3/16
Elmore's Wire Company	2	1-1½
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	9½-10½
—— Preference	—	12
House-to-House Company, Ordinary	5	2½-2¾
—— 7 per cent. Preference	5	6¾-7
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	—	7-7½
Liverpool Electric Supply, Ordinary	5	7 5/16-7 7/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8½-8¾
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	½-¾
Metropolitan Electric Supply	10	9¾-10½
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	5⅝-5¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	7-7½
Oriental and Electric Company, £1 shares	1	11/16
—— £5 Shares	—	7-7½
—— £4½ shares	—	5½-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7½-8½
—— 7 per cent. Pref.	5	8½-9½
Swan United	—	—
Telegraph Construction and Maintenance	12	41-46
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7½-8
Yorkshire House-to-House	5	5½-5¾

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NOTES.

South Africa.—Buluwayo and Salisbury are now connected by telegraph.

Joined in Parallel.—The marriage has taken place at the Fulham Parish Church of Mr. J. D. F. Andrews and Miss Amy Beatrice McKrill.

Electric Traction in Switzerland—An electric tramway is to be built at Zurich—from the chief railway station to below Wipkingen.

Electric Lighting in Austria.—The electric light is to be installed in the palace of the Archduke Karl Ludwig in Favoritenstrasse, Vienna.

Transcontinental Telegraph.—The Portuguese at Tete have agreed to utilise the Transcontinental Telegraph Company's standards for their wires, thus ending the dispute up there.

Pacific Cables.—In the Senate at Washington, Mr. Call urged that if cable communication was established between the Sandwich Islands and America, it would go far to counteract British aggression.

Sentence—A man named Patrick Finn was on Monday sentenced to five years' penal servitude for breaking into the warehouse of the London Electric Wire Company, Limited, Playhouse-yard, St. Luke's.

Electrically-Lighted Ambulance.—Mr. Robert Feilendorf has, for the Vienna Volunteer Ambulance Corps, installed the electric light inside and outside two ambulance wagons. The arrangement is giving satisfaction.

Underground Conduit System.—A new underground conduit system for electric tramcars has been devised by the Hoerde Bergwerks and Hütten Verein. Illustrated particulars are given in the *Elektrotechnischer Anzeiger* of 10th inst.

Students of the Institution.—A students' meeting of the Institution of Electrical Engineers will be held in the library of the Institution, 28, Victoria-street, on Friday next, the 22nd inst., at 8 p.m. Mr. E. C. Hoadley will read a paper on "The Efficiencies of Dynamos and Motors, and their Measurement."

Lecture.—Prof. Kennedy, the consulting engineer of the Edinburgh Corporation, was to have lectured last week on the electric lighting of Edinburgh to the members of the Edinburgh Literary Institute. He was, however, prevented by indisposition from attending, but Mr. Monkhouse, the resident engineer, read the lecture.

Northern Society of Electrical Engineers.—The ballot for new members on Monday last resulted in the election of the following: Messrs. W. F. D. Duncan, of Wigan; A. B. Mountain, of Huddersfield; John Platt, of Roubaix, France; R. O. Ritchie, of Leeds; R. Shaw, of Manchester; and Chas. Turner, of Salford.

Institution of Electrical Engineers.—An extra meeting will be held by kind permission of the council of the Society of Arts at their rooms, 18, John-street, Adelphi, W.C., on Thursday next, the 21st inst., at 8 p.m. The following paper, by Dr. John Hopkinson, M.A., F.R.S., past-president, will be read: "Propagation of Magnetism in Iron," illustrated by experiments.

Waterloo and City Railway.—A suggestion was made to this company last week by Mr. Archibald Scott, who recommended that a station should be constructed on the north side of Blackfriars so as to tap the extensive traffic in that neighbourhood. The directors decided to consider the suggestion. The work of constructing the railway is being carried on night and day.

Economical Working of Arc Lamps.—In our issue of November 23, 1894, we described a mechanical device brought out by Messrs. Hardtmuth and Co., of Vienna, for ensuring economy in the consumption of arc lamp carbons. We now note that *L'Energie Electrique* of February 1 describes a similar arrangement for use both with direct and alternating current arc lamps.

London-Paris Telephone Service.—The Postmaster-General, in answer to Mr. Henniker Heaton in the House of Commons on Tuesday, said that during business hours the telephone between London and Paris was in constant use, so that there could be no doubt there was a demand on the part of the business classes for such communication. He could not see his way to reduce the rate for a three minutes' conversation from 8s. to 3s., as had been suggested.

Personal.—Two of Prof. Jamieson's assistants at the electrical engineering laboratory of the Glasgow and West of Scotland Technical College have just received appointments. One, Mr. William Murray Morrison, has been chosen by the British Aluminium Company, Limited, to assist them in their manufacture of aluminium by the electrolytic process. The other, Mr. David A. Ramsay, has been elected, out of about 100 candidates, to be an electrician at Helsby, in the works of the Telegraph Manufacturing Company, Limited.

Royal Meteorological Society.—An ordinary meeting of this society will be held at 25, Great George-street, Westminster, on Wednesday next, the 20th inst., at 7.30 p.m. The following papers will be read: "Report on the Phenological Observations for 1894," by Mr. Edward Mawley, F.R.Met.Soc.; "The Thunderstorm and Squall of January 23, 1895," by Mr. William Marriott, F.R.Met.Soc.; and "On some Gradual Weather Changes in Certain Months at Greenwich and Geneva," by Mr. Alexander B. MacDowall, M.A., F.R.Met.Soc.

Electric Lighting in Madras.—A new department is being opened at Madras by Messrs. P. Orr and Sons, of that town. According to the *Indian Engineer*, the firm intend to more particularly apply themselves to the best known methods of artificial illumination, with kerosene lamps, gas, and electric light. If the electric light is desired, a Crossley Otto gas-engine will be fixed for the operation of a dynamo. Messrs. P. Orr and Sons are agents for the Otto gas-engine and the Crompton dynamo, together with the manufacturers of all the fittings and accessories.

New French Cables.—According to a *Times* correspondent, the "François Arago" has left Calais with the 260 miles of cable manufactured by the Société des Téléphones, and will stop at St. Tropez to take in the 200 miles of cable contracted for by M. Grammont. These cables will be laid between Majunga and Mozambique, where a connection will be made with the cable of the Eastern and South African Company. "It is deplorable," remarks a Paris journal, "to be forced still to use English cables. It proves the vital necessity for our country to extend the system of French cables."

Electricity and Water Power.—Recognising the increasing attention now being paid to the profitable utilisation of water power, Messrs J. P. Hall and Co., of Blackriding Ironworks, Werneth, Oldham, have issued a new price-list of turbines and dynamos. The illustrations show dynamos direct coupled to turbines, and the advantages of using water power are clearly indicated. The construction of the Girard turbine is represented in cross-section, together with a brief description, and illustrations of the Jonval turbine are also given. Complete details of the

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horse power of these turbines for different falls will be found in the list.

Proposed Pacific Cable.—Matters in connection with the proposed Pacific cable have progressed so rapidly recently that Canada has submitted a proposal for the appointment of a joint commission, to meet in England, to discuss the details of the project. It is suggested, a *Times* correspondent says, that the commission shall consist of three representatives—one of Great Britain, one of Canada, and one of Australia. A telegram from Washington on Tuesday states that the Bill for the incorporation of the International Pacific Company to lay a cable between California, Hawaii, and Japan has been introduced in the House of Representatives.

New Mains.—The Highways Committee of the London County Council have approved of the application of the House-to-House Electric Light Supply Company to lay mains in High-street, Allen-street, and Abingdon villas, Kensington, but decline to allow a transformer-chamber to be used. The same company will also lay mains in Drayton-gardens, Philbeach-gardens, and Earl's Court-road. Approval has been given to applications by the Westminster Electric Supply Corporation to lay mains in Birdcage-walk, Queen Anne's-gate, Regency-street, Carey-street, Fyne-street, Dorset-street, and across Vauxhall Bridge-road, and by the Notting Hill Electric Light Company to lay mains in Holland-park.

European Glow Lamp Manufacturers' Union.—The quarterly meeting of this union has been held at Vienna. It was reported that the objects and regulations of the union had proved not only of great utility to the firms associated therewith, but also to the whole electrical industry, and it was decided to maintain the union. Expectations exist that the French manufacturers of incandescent lamps will join the body. The establishment of a black-list had, it was stated, proved of value. A communication was received from the Electrotechnical Society of Vienna suggesting that the manufacturers should establish a code of normal conditions, and Mr. Johann Kremenesky was deputed to go into this matter with the committee of the Electrotechnical Society.

Municipalisation of Tramways.—The Highways Committee of the London County Council reported on Tuesday that, in response to their advertisement inviting tenders for the lease of the portion of tramways about to be transferred to the Council, they had only received one offer, and that was from the London Street Tramways Company itself. The term of the lease was to expire on December 31, 1900, and the company offered to pay an annual rental of £5,729, but there was a doubt as to the company's power to take a lease. Taking into consideration all the circumstances of the case and the absence of competition, the committee thought the company's offer reasonable, and recommended its acceptance, conditional upon the company's obtaining powers to take a lease. The Council adopted the recommendation.

The Government and the Telephone Companies. The Postmaster-General, in reply to Mr. H. C. Morton in the House of Commons, stated that he had received deputations from the London County Council and the Association of Municipal Corporations on the subject of the agreement with the telephone companies, and he was glad to think that those interviews had removed some of the objections or misapprehensions which were felt as to the effect of the agreement. The agreement merely embodied the heads of the arrangement signed by his predecessor in 1892, in accordance with the report of the Select Committee of the House, and with the policy approved by Parliament in the Telegraph Act of that year. Under these circumstances the Government did not consider that there would be any advantage in referring the matter to a fresh committee.

Party Walls.—The Tribunal Civil de Périgueux have just decided that a party wall is the co-proprietary of two neighbours without either of the two being able to claim the exclusive proprietary of any portion of the wall. Thus it follows that a third party cannot utilise the wall without the consent of both of the proprietors. It appears that the local electrical company, having obtained permission from M. Brachat to put up iron standards for the accommodation of electrical conductors on a party wall separating the latter's premises from those of M. Delpal, carried out the work. Thereupon M. Delpal brought an action against the company, and in deciding the case in the sense indicated by the opening lines of this note, the Court ordered the company to remove the standards and condemned them in costs.

Elevated Railways.—Several schemes for elevated railways have been brought before the German public lately. One by Mr. Eugen Langen, to which we have previously referred, and which he is trying to introduce in Berlin, consists of a single row of columns, each having a T-piece, which supports the superstructure. The carriages are suspended from vertical wheels which run along this superstructure, the whole being sufficiently high to clear the carriages from obstructions in the streets. A modification of this system has been worked out by Messrs. E. Dietrich and H. Müller, professors in the Royal Technical High School, Berlin. Their structure is considerably lighter, and the wheels are placed in almost a horizontal position. Both plans, particulars of which appeared in a recent issue of the *Elektrotechnische Anzeiger*, of Berlin, bear a resemblance to the American Boynton "Bicycle" railway.

Taxation of Machinery.— A meeting of members interested in the Rating of Machinery Bill took place at the House of Commons on Wednesday week, for the purpose of settling the form in which the Bill on this subject was to be introduced in the current year, and to make the necessary arrangements for promoting its success. Among the members present were: Sir William Houldsworth (in the chair), R. G. C. Mowbray, H. Smith-Wright, W. H. Holland, H. J. Roby, Gerald Balfour, W. E. M. Tomlinson, E. Strachey, M. Oldroyd, W. Mather, and W. Coddington. It was announced that a large number of members had intimated their intention to take part in the ballot for places, which in the usual course is held at the commencement of every session, and after careful consideration it was decided to introduce the Bill in the form in which it was brought before the House last session. As the result of this ballot yesterday week, Mr. Gerald Balfour was again fortunate in securing the third place upon the list of private members' Bills, and the supporters of the Bill therefore commence their campaign this session with excellent prospects.

Street Explosions.—The *Lancet* has gone somewhat out of its way to deal with this matter under the somewhat sensational heading of "The New Street Danger." The conclusion which our medical contemporary comes to is that "a time will probably come when electrical engineers will find themselves in practical agreement as to the best and safest systems of laying underground electric lighting mains, but in the meantime existing systems have to be dealt with. It is evident that underground electric mains, culverts, and boxes constitute in some instances reservoirs of considerable capacity for an accumulation of escaping coal gas, which, unmolested and ever increasing, only awaits the electric spark or arc or red-hot conductor, or the lamp of the workman or a discarded match, to

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determine its explosion. The means of minimising this kind of danger by ventilation, drainage, insulation, and attention to the construction of street boxes with a view to the reduction as far as possible in their capacity, are sufficiently well known. And searching enquiry should follow all such accidents. But it may also be suggested that inspection might materially diminish the frequency of their occurrence."

Transformer-Chambers in London.—The Highways Committee of the London County Council on Tuesday reported as follows: "On 29th January we reported, in connection with the orders applied for by the County of London and Brush Provincial Electric Lighting Company for power in (*a*) Battersea, (*b*) Newington, and (*c*) St. Olave's district, that we had under consideration the question of suggesting to the Board of Trade the expediency of provisions being inserted limiting, if not prohibiting, the adoption under any one of the orders of a system of supply which would involve the construction of transformer-chambers of large size in the public streets. We have since been informed that there would be little value in such a provision as that indicated above, as no system of supply necessarily involves the placing of transformer-chambers under the streets; but, to attain the end we have in view, we now recommend, that it be suggested to the Board of Trade that the following words be inserted in each of the orders above referred to: 'Provided always that nothing in this order shall be held to authorise the undertakers to construct, in or under the surface of any public street or place, chambers or receptacles for transforming apparatus of greater span than 3ft. and more than 2ft. 6in. in depth.'"

"Universal Electrical Directory."—The 1895 edition of this well-known directory (J. A. Berly's), which has established a very high reputation throughout electrical circles, has just been issued, at the price of 4s., by Messrs. Alabaster, Gatehouse, and Co., of 22, Paternoster-row, E.C. The "red book," as it is now generally termed, occupies one of the most prominent positions in the branch of trade directories. The present issue, which contains the names of the members of the electrical and kindred industries throughout the world, has been thoroughly revised, and the British alphabetical section now comprises about 9,168 distinct names; the Continental section, 6,490; the American section, 3,922; and the Colonial section, 1,378, being a total of 20,958. This number embodies approximately 2,500 names of individuals and firms more than were contained in the previous edition. The directory, for simplicity and facility of reference, is divided into four groups—namely, British, Continental, American, and Colonial—which are again subdivided into alphabetical and classified sections. Apart from the new names incorporated in the present edition, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total pages added to the work are 80 as compared with that of 1894, making, in all, about 866 pages entirely of directory matter. This directory is indispensable to the electrical trades.

Electric Locomotives for Mines.—The great advantages accruing through the adoption of electric locomotives in mining operations is exemplified by a letter which the Acme and Immisch Electric Works, Limited, of Queen-street-chambers, E.C., and Chalk Farm, N.W., have received from Mr. W. H. Borlase, the manager of the Greenside Mining Company, Limited, of Greenside, Patterdale, Westmoreland. In the course of his communication the writer says: "You will be pleased to hear that our electric locomotive has just completed 6,000 miles of running, with an average working load of 20 tons, at a cost of only £12, and this for renewing the training wheels, which have just been replaced. The wearing of these can be to a great extent accounted for, seeing that some of the gradients are equal to 1 in 20, necessitating a heavy brake being applied occasionally. The electrical part of the locomotive has required no repairs whatever, the armature and commutator apparently are as good as at the first, and the latter has never been turned up since it left your works. Taking into consideration the exceedingly sharp curves and their frequency in the line of rails, to say the least, the wear and tear is really surprisingly low, and does great credit to the workmanship on the machine. In fact, the whole of the extensive electrical plant you have supplied us is in splendid working order, doing good duty, and has from its erection (now three years) proved thorough efficiency at an infinitesimal working and repairing cost. We look upon the work accomplished by the locomotive as marvellous, it having far exceeded our expectation in ability and cost of maintenance."

Testing, Mathematical, and Telegraphic Instruments.—It is scarcely necessary to say that almost throughout the world the testing and telegraphic appliances made by Messrs. Elliott Bros., of 101 and 102, St. Martin's-lane, W.C., are to be found in daily use; whilst at the same time their electrical, optical, engineering, and mathematical apparatus have been largely adopted by the English and other Governments. The instruments manufactured by the firm are also used by the Board of Trade, London County Council, and important standardising laboratories, and by electric supply companies, and in colleges and universities in all parts of the world. It is now some time since Messrs. Elliott Bros. issued a new catalogue, but they have now done so, and the copy lying before us is an elaborately illustrated production of some 150 quarto pages. It would be impossible to more than briefly enumerate the very large variety of instruments referred to in the catalogue, but there may be taken as a fair sample: galvanometers of various types and shunts, lamps, scale stands and scales for reflecting instruments, standard resistances, Wheatstone bridge coils, Lord Kelvin's rheostats, sets of resistance coils, portable testing sets, electrometers, keys and switches, standard cells and accessories for use with testing apparatus; telegraphic instruments of all kinds, chronographs and other recording instruments, drawing apparatus, length-measuring appliances, goniometers, spectroscopes, Lord Kelvin's standard balances, photometers, etc. In fact, the catalogue deals with every kind of instrument required in a telegraph office, college, laboratory, or central station.

County of London Company.—Subscriptions are invited for a first issue of 10,000 6 per cent. cumulative preference shares of £10 each at par, and a further issue of 10,000 ordinary shares of £10 each at 5s. per share, in the County of London and Brush Provincial Electric Lighting Company, Limited, which was registered in June, 1891, for the purpose of undertaking the supply of electricity in certain districts in the county of London, and elsewhere in the United Kingdom, where capital may be profitably employed in electric supply. In March, 1894, an issue of 19,900 ordinary shares of £10 each was made and fully subscribed, making with 100 shares previously subscribed a total issue of £20,000 shares, but an official quotation has not been obtained, as, according to the rules of the Stock Exchange, no such quotation can be granted until one-half, at least, of the capital of the company has been offered to the public. The directors have therefore resolved to comply with the requirements of the Stock

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Exchange and to provide for the development of the company's business by offering the present issues of preference and ordinary shares. It is intended that future issues of preference shares shall be made only at a premium. The directors consider that the earnings of the company during the present year will be amply sufficient to pay the amount required for dividend on the present issue of preference shares. In the prospectus issued in March, 1894, it was stated that provisional orders, confirmed by Acts of Parliament, for the following districts in the county of London had been obtained: the united parish of St. James and St. John, Clerkenwell; the parish of St. Luke, Middlesex; the district of the Wandsworth Board of Works, including portions of Putney, Clapham, Balham, Upper Tooting, Tooting, Brixton Hill, and Streatham Hill; and the parish of St. George-the-Martyr, Southwark. Since then, considerable progress has been made with the works. In London, sites have been secured for power stations for St. Luke's, Clerkenwell, and Wandsworth, and the laying of mains and other necessary work has been energetically carried on. Plant for the supply of 90,000 8-c.p. lamps is in course of manufacture, and it is expected that the supply of current in these three districts will be commenced from the company's stations in the autumn of the present year. The company is also associated with the stations at Bournemouth and Dover, and with the Windermere project. The list will close at 4 p.m. to-day (Friday). The address of the company is 49, Queen Victoria-street, E.C.

The L.C.C. and Telephones.—On Tuesday the Highways Committee of the London County Council reported as follows: "The Council on 3rd October, 1893, referred it to us to consider how far the proposed agreement about to be made between the National Telephone Company and the postal authorities would affect the Council's position in regard to the telephone service in London, and we were at the same time authorised to confer with the Postmaster-General on the subject. Proceeding upon this reference, we looked very carefully into the provisions of the agreement; and we soon came to the conclusion that, if the agreement were carried out, the interests of the people of London in the matter of telephone service would be to a great degree prejudiced by the power given under the agreement to the National Telephone Company, whose existing monopoly would be further strengthened. Moreover, we did not find in the agreement any provision or arrangement for reduction of charges, a matter of grave importance to the business people of London. We therefore came to the conclusion that one of three courses should be taken—namely (*a*) that severe restrictions should be placed upon the company; (*b*) that the State should take over the company's business; or (*c*) that the municipality—*i.e.*, in London, the Council—should do so. We requested the Postmaster-General to hear us by deputation, which he did on Monday, the 4th of February. The Postmaster-General stated that the agreement was practically entered into between the Government and the telephone companies in the year 1892, but that he had consistently maintained in the negotiations with the telephone company that the company has no monopoly, and that the Government is perfectly free either to carry on the telephone business itself or to give powers to other licensees. He did not, however, appear to think that the Government would be able to give facilities for a long discussion in the House of Commons, although some discussion might take place. In view of the answer of the Postmaster-General, we think that every effort should be made to obtain some modifications of the agreement before it is finally ratified, and it occurs to us that this object would be best attained by the agreement being referred for consideration by a Select Committee of the House of Commons; and we may say that the Commissioners of Sewers of the City of London have passed a resolution to this effect, and have sent a copy of it to the Postmaster-General as well as to the Council. We recommend that the London members of Parliament be requested to ask for the appointment of a Select Committee of the House of Commons to make full enquiry into the proposed agreement between the Postmaster-General and the National Telephone Company, and the relation of such agreement to the powers and duties of municipal authorities in London and elsewhere."

Municipalisation of Telephony.—The deputation representing the Town Councils of Glasgow, Edinburgh, and Aberdeen, who waited upon Mr. Arnold Morley in London on Monday for the purpose of urging that they should be granted licenses for carrying out municipal systems of telephones, and that the draft agreement with the National Telephone Company should not be confirmed, did not receive much consolation. In the course of his reply to the deputation Mr. Morley remarked: "I am a great believer in the municipal government system in this country, and with regard to all matters which can be distinctly shown to be matters with which municipalities can effectively deal, I should be the last man in the world to turn a deaf ear to any such suggestions. But the Government have to look at this matter from a different point of view. You have come to press on the Government that this matter should be treated as a municipal matter, but I wish to point out that the Association of Municipal Corporations in England have come to an entirely opposite decision. They put in the forefront of the case that the telephone system ought to be treated as an Imperial matter, and not as a local matter. If we once begin a system of municipal telephones, it is very difficult to say how far it would be possible to put a stop to it. My own belief is that the State must ultimately have complete control. This agreement does not prejudice that question at all. The only effect of this agreement, substantially and practically, speaking, is that the State should take over the trunk-wire system. The Government have suggested a scale of charges for the trunk-wire system. It is not exactly identical with that of the National Telephone Company, but I understand the latter, having made certain charges for trunk wires which are somewhat below what would be the charges on the Government scale, have intimated that the time is very shortly coming when, if the system is continued, they will have to revise the scale, as it is not sufficient to cover the cost. When the Government have control of the trunk-wire system, the municipalities would be able to bring pressure to bear on the Government to bring the charges down to a reasonable amount much more effectively than if the trunk wires remained in the hands of a company. Therefore, I do not think the telephone-using public are likely to be damaged by the fact of the Government taking over the trunk wires. Something was said about the creation of a monopoly by this agreement. I can assure you that there is no foundation for anything of the kind." In reply to further questions, Mr. Morley said he had no power to transmit the right of appeal to a licensee, and he would not do it if he could. He could not consent to an enquiry by a parliamentary committee which would reopen the whole question as to the trunk wires, but he would consult his colleagues as to the propriety of appointing a committee to enquire as to the working of the system in towns and as to the charges to come, and before which the corporations would lay their case.

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THE ELECTRICITY WORKS AT BLACKBURN.

General Remarks.

The county borough of Blackburn contains an estimated population of about 126,000 inhabitants with a ratable value of £441,111, and the Corporation, as a progressive municipal body, are the owners of the gasworks, waterworks, markets, cemetery, free library, public baths, technical school, and two public parks, whilst at the same time the borough has its own quarter sessions. The staple trade of the town is cotton spinning and weaving, there being no less than 1,279,346 spindles and 66,335 looms.

The Corporation, in common with other corporations and local authorities, found it advisable in 1890 to apply for and obtain a provisional order giving them the exclusive right to carry out the electric lighting of the town, as, had they not taken this course, there were public companies ready and willing to obtain the necessary powers and to undertake the electric lighting of the town.

As there is a profit to be made out of electric lighting, the Corporation prefer that whatever profit there is to be made should be applied in the relief of the rates. After careful consideration by the Gas Committee, to whom the question of electric lighting was referred by the Town Council, it was decided to adopt a site at the No. 1 gasworks for the erection of the station, and part of the gasworks buildings was made available for the purpose. The necessary alterations to these buildings were carried out under the superintendence of Mr. Samuel R. Ogden, the borough gas engineer, at a trifling cost.

It was considered all the more advisable by the committee to adopt this site because it appears pretty certain that in the future, after the present gas-making plant at the No. 1 works has been worn out and becomes superseded by more modern appliances, it will not be desirable to continue the gasworks at that site, and consequently there will be ample room for future extensions of the electric light station.

A report and estimates of the installation were submitted to the Gas Committee of the Corporation by Mr. Thomas Barton, electrical engineer and contractor, carrying on business in Blackburn, and on his recommendation a low-pressure direct-current system was adopted, and the station has been erected.

The contracts for the steam and electrical plant were placed with the following firms:

Messrs. Yates and Thom, Blackburn, boilers, steam-pipes, pumps, etc.	£2,330
Messrs. Siemens Bros., Limited, London, steam-engines and dynamos	4,820
Messrs. Siemens Bros., Limited, switchboard	770
Electrical Power Storage Company, London, accumulators	2,150
Messrs. Siemens Bros., Limited, cables (not including excavation, etc.), junction, feeder, connecting boxes, etc.	5,860
Messrs. Doulton and Co., London, stoneware insulators	350
Messrs. Ashton, Frost, and Co., Blackburn, iron culverts	3,000
Messrs. Ashton, Frost, and Co., steel junction-plates for culverts, at 6s. 6d. per cwt.	550

Blackburn.—Map Showing Route of Feeders, Distributors, and Feeder Points.

The excavation of the streets for laying the cables, the making good, and all brickwork in connection with the feeder and junction boxes were also carried out under the superintendence of Mr. S. Ogden.

In September, 1894, the Town Council having decided to obtain further advice, Mr. E. M. Lacey, A.M.I.C.E., of 19, Old Queen-street, Westminster, was retained as consulting engineer to the Corporation during the erection of the electric lighting installation. Messrs. Siemens Bros. commenced the laying of the cables at the end of last September. It was originally intended to supply consumers on a portion of the system by the arrival of Christmas, but owing to certain delays and to the recent frosts, the progress of cable-laying has been impeded, and the opening of the station has thus therefore been retarded down to the present time.

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The System Adopted.

In December, 1894, as the works were so near completion, the Council considered it advisable to advertise for a resident electrical engineer to take charge, with the result that Mr. A. S. Giles, A.I.E.E, formerly of the Edison-Swan Company, was appointed, having been selected from amongst a large number of applicants. Mr. Giles has accepted an appointment from the Committee of the Blackburn Technical School, with the sanction of the Corporation, and will conduct for the special benefit of apprentices and workmen engaged in electrical work a course of practical instruction, which promises to be of great value to the town and district generally.

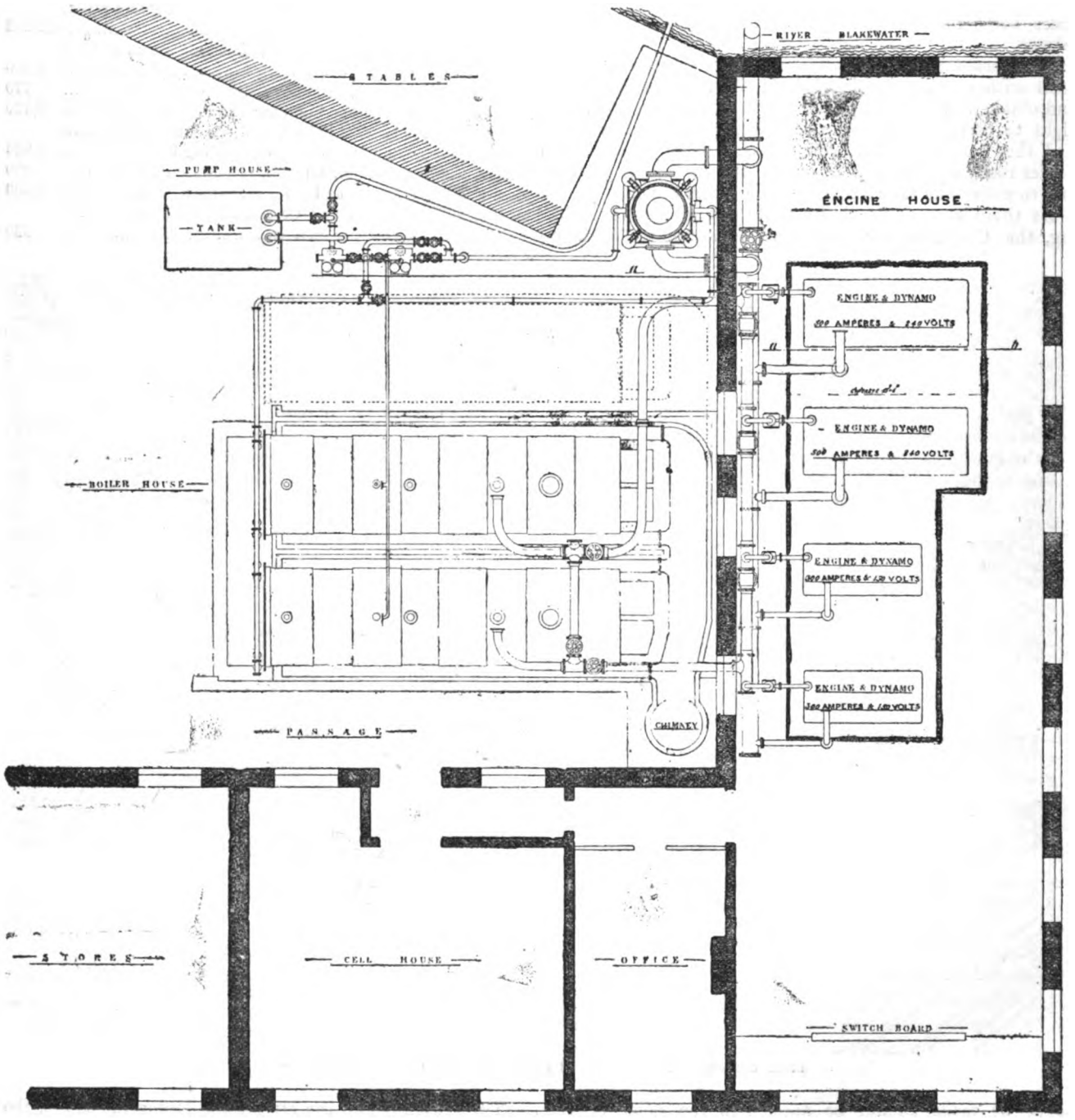
So far as the system adopted is concerned, there is little that is novel, the method being direct-current and low-pressure distribution on the three-wire system. The works were designed with a view to supply the principal streets in the centre of the town, as shown on the annexed map.

The works are situated in Jubilee-street, and adjoin the Corporation gasworks. The buildings comprise engine and boiler houses, accumulator, meter, and engineer's rooms, and stores. The boiler-house is at present of a temporary character. The engine-house is 87ft. long by 24ft. wide, which allows ample room for any extensions of the machinery which may be required at the present works.

The Boilers.

At present two Lancashire boilers are fixed, and accommodation is provided for a third boiler, which will shortly be placed in position. The boilers were made by Messrs. Yates and Thom, of Blackburn. They are 28ft. in length and 7ft. 6in. in diameter. Each boiler has two internal flues 3ft. in diameter, and is fitted with four Galloway tubes. The boiler mountings throughout are by Messrs. Hopkinson, of Huddersfield. The boilers, which are constructed for a working pressure of 120lb. per square inch, are equipped with Proctor's mechanical stokers, which are driven by a small electric motor supplied by Messrs. Siemens and Co.; and Meldrum's furnaces, made by Messrs. Meldrum Bros., of Atlantic Works, Manchester, have been adopted.

Amongst other advantages claimed for the Meldrum furnaces are—economy in steam raising; that by the employment of forced draught, cheap fuels, such as coke breeze or other waste fuels, can be utilised; and that the power of the



BLACKBURN ELECTRICITY SUPPLY STATION

Blackburn.—General Plan.

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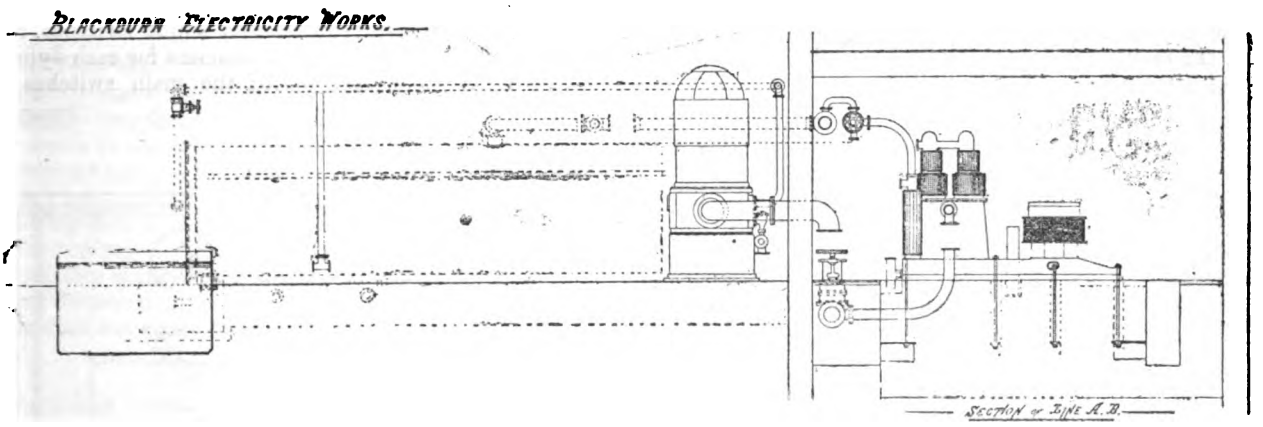
boilers can be increased to much beyond that obtained by the employment of natural draught, except by means of a somewhat costly edifice. Therefore, it should be possible to put down fewer boilers to meet the maximum load, and in cases of emergency these furnaces are capable of rapidly increasing the rate of combustion to meet any sudden demand for steam that may arise at a central station through fogs or other causes. This system, it will be remembered, has been adopted with great success in many central stations.

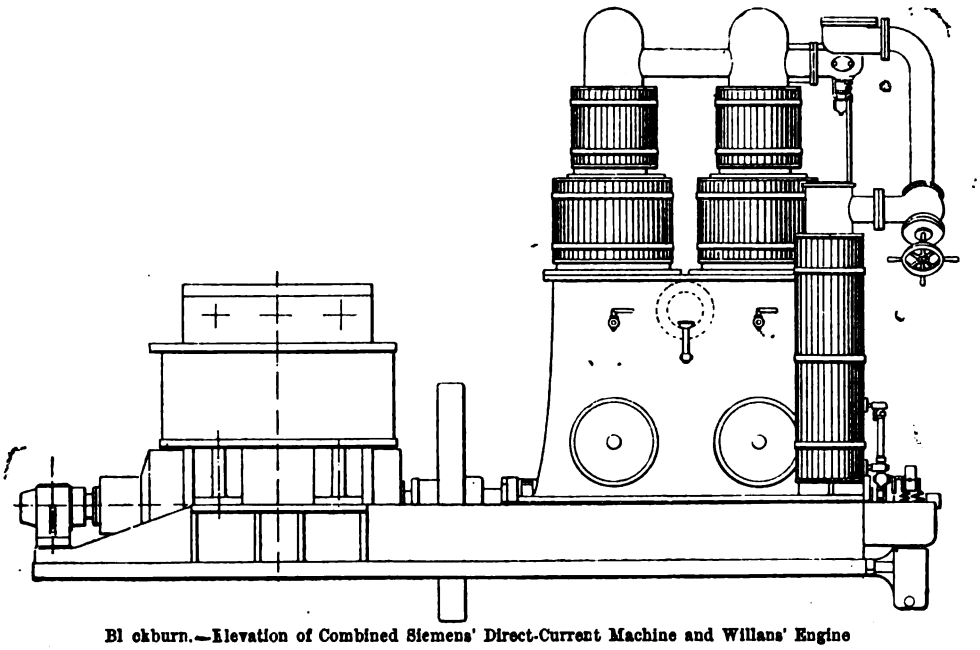


Blackburn.—Cross-section through Boiler and Engine Houses.

The water supply is obtained either from the River Blakewater or from the Corporation mains, and a storage tank has been provided holding about 2,000 gallons. From this tank or from the river the water is drawn by two Worthington vertical marine-pattern pumps, each capable of delivering 4,000 gallons per hour, and fed into the boilers through an improved exhaust-steam feed-water heater.

It is through this heater that the exhaust steam from the engines is passed for the purpose of heating the feed-water supply to the boilers. This heater, which has been provided by the Patent Heater Condenser Company, of 16, Great George-street, Westminster, London, S.W., is of the company's No. 14 special type for electric light stations, made extra strong for a working pressure of 120lb. per square inch, and capable of raising the temperature of 3,000 gallons of water per hour to 200deg. F. by means of exhaust steam only. The heater is 13ft. high and 5ft. 5½in. square at the base, and is fitted with an arrangement by which the casing can be raised with the smallest amount of labour, there being only one point to break, so that the whole of the internal tubes are very easily accessible for inspection or cleaning. The water inlet and outlet connections are on the cast-iron body of the heater and not on the casing, as in the ordinary heaters. The casing is therefore left entirely free for removal by the new arrangement. The casing is 54in. in diameter, and is made of mild-steel plates planed on the edges and hydraulic riveted. The exhaust steam inlet and outlet are 20in. in diameter, and all the internal tubes are of best solid-drawn brass and copper. The heater is also fitted with the company's new wrought-iron bottom for the prevention of back pressure.

The system of steam-piping is clearly shown in the general plan of engine and boiler houses. It is arranged in a ring form, valves being provided to allow of any portion being cut out without interfering with the supply to the engines. The main steam-pipes are of wrought iron, with wrought-iron flanges, the tee pipes being of cast iron. They are suspended from the walls of the engine-house by means of rods and brackets, allowance being made for expansion. The bends and branches to the engines are of copper. Suitable arrangements are provided for draining the sections of the steam-pipes.



Blackburn.—Elevation of Combined Siemens' Direct-Current Machine and Willans' Engine

The main exhaust-pipe is of cast iron 12in. diameter, and is carried as shown on the plan, branches being provided for the purposes of forming a way either through or by the heater.

Steam-Engines and Dynamos.

Four compound engines, made by Messrs. Willans and Robinson, of Thames Ditton, of the Willans central-valve type, have been put down, the dynamos being mounted on the engine bed-plates and direct driven. Two of the engines are of the Willans II. type, and the other two are of the G.G. type. The guaranteed efficiency is 22½lb. of water per indicated horse-power.

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The dynamos are by Messrs. Siemens Bros., and are of their usual central-station type, with drum armatures, the field coils being shunt wound. The two larger machines have each an output of 500 amperes at 240 volts, with a speed of 330 revolutions per minute, and the two smaller machines each have an output of 300 amperes at 150 volts, with a speed of 450 revolutions per minute.

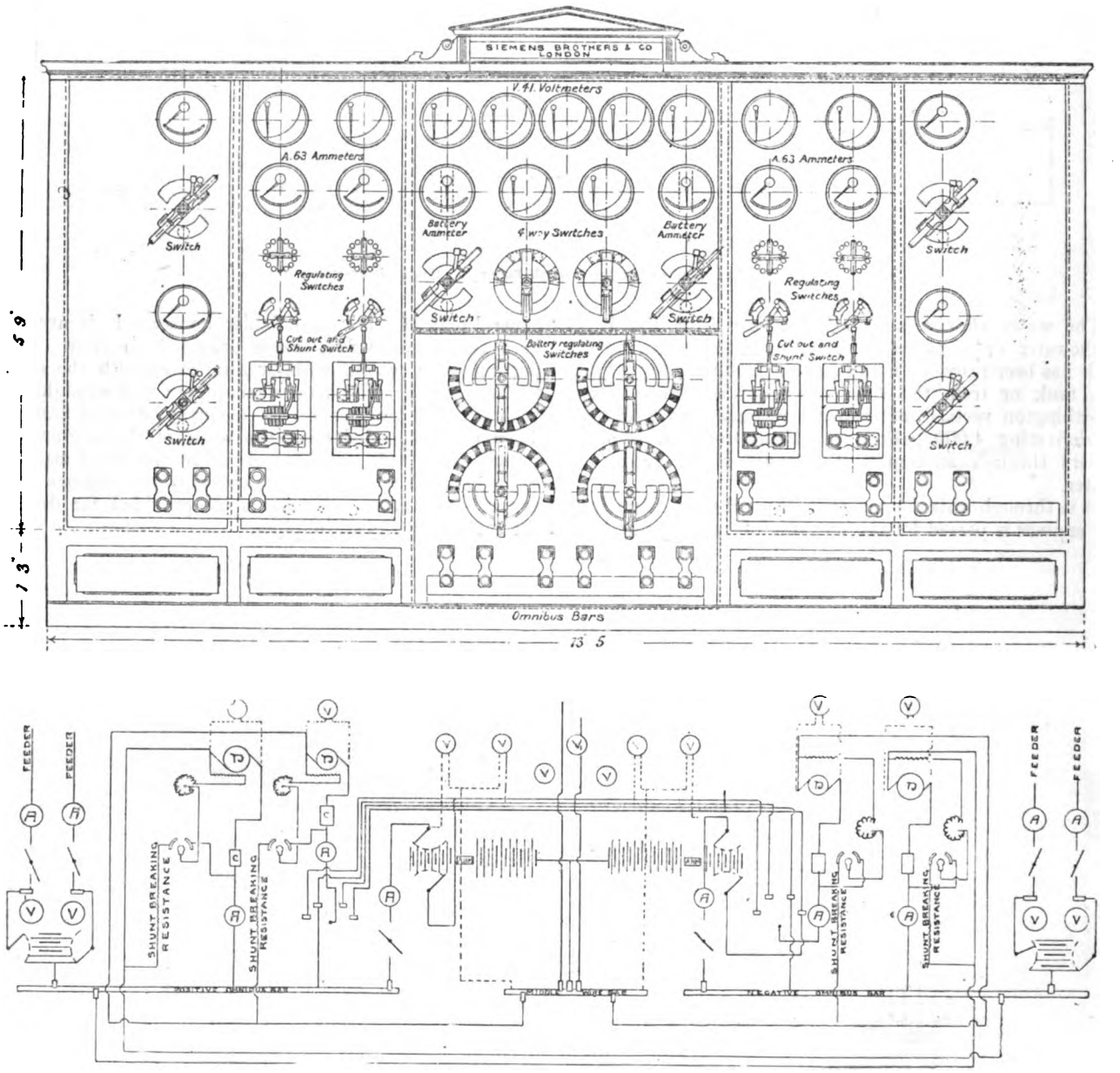
The guaranteed efficiencies of the combined engines and dynamos are as follows: for the large sets, 82 7 per cent. at full load, and 72 8 per cent. at half load; for the small sets, 79 2 per cent. at full load, and 68 per cent. at half load.

The engine and dynamo plant has been put down to meet the requirements of the current supply for the equivalent of 10,000 8-c.p. lamps installed.

The Switchboard.

The switchboard is situated, as shown on the plan, at the north end of the engine-house. The general arrangement of the switchboard is represented and the connections are shown in the annexed elevation and diagram.

The board consists of five panels of enamelled slate. On the centre panel are placed the battery regulating switches, the battery ammeters, voltmeters, and two four-way switches for the small dynamos, so that either of these dynamos can charge on to either side of the accumulators. The panels on either side of the centre panel contain main automatic cut-out and shunt switches, regulating switches, ammeters and voltmeters for each dynamo. On the outer panels are placed the main switches and



Blackburn.—Elevation of Switchboa and Diagram Connections.

Accumulators.

These consist of 120 cells, each containing 87 K-type plates, arranged in three sections of 29 plates each, connected in parallel, and made by the Electrical Power Storage Company, of 4, Great Winchester-street, London, E.C. These cells are capable of giving a discharge of 300 amperes at 240 volts for 3½ hours, or on an emergency are capable of discharging 850 amperes for one hour. The containing boxes are of lead with insulated bottom, and provided with lips to prevent electrical leakage due to creeping of the acid. The cells are placed on varnished wood trays on glass oil insulators. All connections are designed with a view to prevent undue rise in temperature when the batteries are discharging at their maximum.

ammeters for the feeders. On these panels, also, the feeder regulating switches will be placed.

The leads from the dynamos and accumulators are brought on the switchboard to omnibus bars, which are capable of being regulated to any required difference of potential. From these bars, feeders are taken to the feeder points. Each feeder will be provided with additional independent regulation by means of regulating switches and counter E.M.F. cells. The output of the station is measured by means of Thomson's watt-hour meters attached to each feeder. The whole of the switches, instruments, and apparatus on the board were made and supplied by Messrs. Siemens Bros., Limited. Mr. Vincent was in charge for that firm of the whole of the station work.

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The Mains.

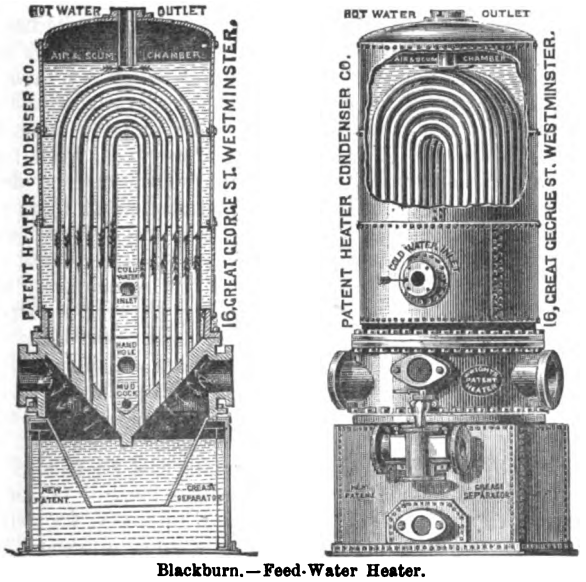
The cables have been supplied by Messrs. Siemens Bros., of London. They are very highly insulated with pure and vulcanised rubber, and have been laid on stoneware insulators in iron culverts. These insulators were made by Messrs. Doulton and Co., of Lambeth, S.E. At present the feeders from the station on to the distributing network are only two in number, each having a cross-sectional area of ·8 square inch for the outer cable and ·5 square inch for the inner. The cables for the distributing network are of three sizes, having cross-sectional areas of ·5, ·3, ·5 square inches, ·4, ·3, ·4 square inches, and ·25, ·2, ·25 square inches respectively.

The tests taken before any house services were connected up came out after two minutes' electrification at over 1,500 megohms per statute mile, a matter of considerable credit to the contractors, taking into consideration the difficulties they had to contend with. Mr. Horn, A.I.E.E., was in charge of this work for Messrs. Siemens Bros.

The services to consumers are vulcanised rubber cables laid in iron pipes. These services are carried to terminals immediately within the consumer's premises, at the expense of the Corporation, provided that the distance from the mains does not exceed 60ft.

Public Lighting.

The public lighting already sanctioned consists of four arc lamps at Sudel Cross, two arc lamps in front of the Town Hall, and two in front of the Market Hall, also two on Salford Bridge, and two at the corner of Church and


HOT WATER OUTLET
AIR & SCUM CHAMBER
PATENT HEATER CONDENSER CO.
16, GREAT GEORGE ST. WESTMINSTER.
HOT WATER OUTLET
PATENT HEATER CONDENSER CO.
16, GREAT GEORGE ST. WESTMINSTER.

Blackburn.—Feed-Water Heater.

Darwen streets, making 12 lamps in all. They are made and supplied by Messrs. Siemens Bros., and are arranged on standards furnished by Messrs. McFarlane and Co., of Glasgow.

Of course, when the Corporation have experienced the advantages of arc lamps for street illumination they will, as has been carried out in other towns, considerably extend their use in the principal thoroughfares. It is not a question of expense, but one of improving the lighting of the main streets to the benefit of the general community.

Private Lighting.

Distributing mains have been laid, and a supply of electrical energy is available in Church-street, Darwen-street, Lord-street, New Market-street, King William-street, a portion of Preston New-road, Richmond-terrace, Library-street, Exchange-street, Victoria-street, etc.

Already upwards of 3,000 lamps have been applied for, and this number does not include the Town Hall, Municipal Offices, etc. Further applications are being received, and it is hoped that the present station will soon be working at its full capacity.

The charge made by the Corporation for electrical energy is at the rate of 7d. per Board of Trade unit, or, say, a little more than the cost of gas in the town at 3s. 7d. per 1,000 cubic feet. But when the incidental advantages of electric light are taken into consideration—a more healthy illuminant, one which does not detrimentally affect wall papers, ceilings, curtains, books, etc., and one which, if judiciously used by the consumer by the aid of switches, is economical—it will be found that a better light is obtainable for the same money as gas.

The consumption of electrical energy will be registered by meters, the rental of which will be from 2s. 6d. per quarter, according to the size of the meter. Then for those who desire to use electric power the charge will be only 5d. per unit.

The Corporation will lay the service wires between their mains and the consumer's premises. They will only bring these lines into the consumer's premises at the point nearest to their service manholes, and will fix the end of their mains into a cut-out box. The consumer's wires must be brought out as far as the Corporation cut-out box, and the ends left ready for sweating in, which will be done by the Corporation. Where the service line required is not more than 20 yards in length from any distributing main of the Corporation, it will be laid free of charge to the consumer's meter; where the length of service line required is more than 20 yards, the additional length of service line will be laid at the cost of the consumer.

Conclusion.

The Corporation are to be congratulated upon having established municipal electricity works. In fact, as they have municipalised water and gas, it would have been a pity to have permitted the electric lighting of the town to have been undertaken by a company. Even the tramcars bear the title of the "Corporation Tramways Company," and the Municipality might do well to favour the adoption by the former of electric traction, and dispense with the unsightly steam cars which grace (!) some of the Blackburn streets. The best wishes of all will be for the success of the electricity works which are now on the point of being officially set in operation. But before concluding, one or two remarks are necessary in regard to two gentlemen in the town.

Notwithstanding the services rendered by the chairman of the Gas Committee (Alderman Thompson) and the town clerk (Mr. Robert E. Fox), the public have reason to be grateful to the Gas Committee as a whole for the intelligent and business-like manner in which they have devoted themselves to this important work.

Mr. Alderman Thompson has spared neither time nor trouble to make the undertaking a complete success during the progress of work; the town clerk also rendered valuable service, and it has been a great advantage to the Gas Committee and a valuable saving of time to have had the benefit of experience and advice such as Alderman Thompson and the town clerk were able to contribute.

RULES FOR INSTALLATION WORK AT BLACKBURN.

The Blackburn Corporation have drawn up the following rules and regulations for the guidance of contractors and consumers:

Wiring.—No system of wiring involving connection to earth of one of the conductors will be allowed to be connected to the Corporation mains. The mains from the Corporation cut-out boxes should be taken to distribution-switch and cut-out boards, and should there be divided into as many small circuits as practicable, each circuit being protected by a cut-out on each pole and governed by a switch. These small circuits should carry no more than five amperes. Where conductors pass through walls or behind plaster they should be run in porcelain or iron tubes, and no joints should be made on them. When conductors pass through party walls, separate porcelain tubes must be used for each conductor. Also when conductors pass through walls dividing one fireproof compartment from another they must be enclosed in separate porcelain tubes. External conductors will not be allowed unless the method of fixing, general arrangement, etc., has first been explained to the electrical engineer and received his approval. Any conductors that are run on, or in the immediate neighbourhood of, or fittings that are secured to, structural ironwork, pipes, or any parts of the building having good connection to earth must be specially well insulated, and efficient means taken to prevent accidental contact. No disused circuit is allowed to be left with the current on the conductors, but should be cut off on both poles close to the mains. In theatres and all buildings such as are considered hazardous risks by the insurance offices, special precautions must be taken, such precautions varying according to the nature of the hazard. All work inside houses is to be carried out in strict accordance with the rules of the fire insurance office in which the building and contents are insured.

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Conductors.—Each conductor shall be of such a sectional area that the current in it shall not exceed 1,000 amperes per square inch, and of such area with respect to its length, that the fall of pressure between the point where the conductors of the Corporation are connected with the installation and the furthest lamp therein shall not exceed 2 per cent. The sectional area of any conductor carrying over 100 amperes must not exceed the ratio of 750 amperes per square inch. All conductors of a larger sectional area than No. 16 S.W.G. should be composed of strands, no conductors of less size than No. 18 S.W.G. should be used except in fittings, and in fittings no conductors should be of less size than No. 20 S.W.G. All conductors must be made of copper of a conductivity not less than 98 per cent. of that of pure copper. Each conductor must be tinned. The ends of all stranded conductors must be solid soldered before being fitted into any cut-out or switch. Concentric conductors will only be allowed under those circumstances and in those places for which permission has first been obtained, and when the particular system and design proposed has been previously approved by the electrical engineer.

Insulation.—The insulating covering of all fixed conductors must consist of at least one coat of pure indiarubber, one coat of vulcanised indiarubber, braided and compounded to preserve the insulation from mechanical injury, and the said insulating coverings must be of such quality and thicknesses that the insulation resistance of any conductor shall not be less than 600 megohms per mile. Should it be desired to use any material other than vulcanised rubber, samples must be submitted to the electrical engineer to the Corporation before the work is commenced, and must receive his approval. Flexible wires must be insulated with vulcanised rubber to 600 megohms as above.

Joints.—All joints to be well and neatly soldered, resin only being used as a flux. All joints in the insulation to be covered with at least six laps of pure rubber, the braiding, cotton, or tape being cut away on either side of the joint, leaving the insulating material and copper conductor to be covered with pure rubber. When this has been done the whole to be covered with protecting tapes, each layer to be soaked in indiarubber solution. No joints to be made in conductors that are buried in casing or tubing in walls.

Casings.—All casings must be composed of sound, hard, and well-seasoned wood. The conductors must be kept apart by a continuous fillet, which should not be less than 1½in. wide in the case of the mains, and not less than ½in. wide in that of the smallest branches. All the covers to be firmly screwed with brass screws fixed in the outer edges of the casings, and on no account in the centre fillet. All casings are, wherever practicable, to be run along the surface, but when it is necessary to sink them into the plaster the casings are to be well painted inside and outside with two coatings of good oil paint. In every case the casings must be painted inside with fireproof paint. Under no condition whatever must staples be used for fastening down conductors.

Cut-outs or Fuses.—All fuses are to be of approved pattern, mounted on suitable incombustible material. A double-pole cut-out must be placed at every change of section of wire, and the fuses must be of such section, length, and nature, that they will fuse and disconnect the circuit if the current passing through exceeds the normal current by 50 per cent. All fuses should be in places easily accessible, and be stamped with the current at which they will fuse. Every cluster fitting or lamp of higher than 16 c.p. must be provided with a double-pole fuse.

Switches.—A double-pole switch and cut-out must be provided and fixed directly at the point of attachment to the Corporation mains, or in such other place as may be determined by the electrical engineer. No metal parts of switches which are in connection with the circuit should be left exposed. All sectional switches must be of good design and mounted upon non-combustible bases, with covers of same material or of metal, and must be arranged so that they do not turn on, at one time, more lamps than require a current of 10 amperes.

Branch Circuits.—Each installation (unless by special permission of the electrical engineer) must be divided into circuits carrying not more than 10 amperes each—that is, current equal to supplying 20 16-c.p. lamps.

Fittings.—All lamp fittings to be well and substantially made, special care to be taken to avoid injury to the conductors contained therein. All fittings as far as possible to be insulated at the base. No fitting to form part of the electrical circuit. Where combination gas and electric fittings are proposed to be used they must first be submitted to and approved by the electrical engineer, and the fittings must be electrically disconnected from the gas supply pipe by means of insulating flanges and bushes.

Three-Wire System.—All installations of more than 100 lamps of 16 c.p. or their equivalent must be wired on two main circuits for connection to both sides of the three-wire system. The two circuits should be made as nearly equal in capacity as possible. In any installation requiring a large and variable supply of current for lighting or motive power, the Corporation reserve the right to supply at a pressure of 220 volts, with subdivided circuits of 110 volts each.

Insulation, Resistance, and Testing.—On receipt of notice at the office that the work is ready, the Corporation will send their inspector, who will make one test and examination free of charge. Before the test is taken, all switches must be placed on and all fuses must be inserted. Should the test be satisfactory, the inspector will then examine the installation to see that all the lamps light. If it should be found that the installation is not ready for testing, or if it fail to pass the test, a fee of 10s. must be paid for each subsequent test before such test is made. Notice in writing should be given to the Corporation, at their office, Jubilee-street, by the wiring contractor at least 48 hours before a supply is required to be turned on, and the contractor must send his representative at the time fixed to give any information concerning the installation that may be required. The Corporation will not supply current to any installation under any of the following conditions: (*a*) if there are any temporary wires or fittings; (*b*) if the work is not carried out in accordance with the rules already stated; (*c*) if the whole of the work is not completed and all fittings fixed; (*d*) if, when testing with a pressure of 110 volts, the insulation resistance to earth is below the following standard—50,000,000 divided by the number of lights installed.

Example.—For an installation of 25 lights the insulation resistance must be $\frac{50,000,000}{25} = 2$ megohms.

WATER-POWER INSTALLATIONS FOR ELECTRIC LIGHTING.

BY E. R. DOLBY, WH.SC.

The reader of technical literature dealing with the subject of the application of water power for the purpose of electric lighting must have been struck with the tone of sorrow in which various writers from time to time deplore the want of judgment of British engineers. They instance the successful use of large and small powers in Switzerland for similar purposes, and though bound to admit that there is in England no great scope for the use of waterfalls, they still appear to think that this source of energy is neglected.

It may be worth while considering what are the advantages in actual practice of the use of water power. There are, so far as the writer is aware, only two practicable sources of energy of this class: (1) that of a flowing stream, (2) that of a distinct fall of water.

(1) Numerous attempts have been made to make use of the energy in flowing water. The author some years ago made experiments upon a floating motor which was moored in the Thames for test purposes. This apparatus consisted of a pair of floating vessels, between which were placed a series of blades *en echelon*; these blades were fixed to a chain which passed over the driving wheels on the deck of one of the vessels. The flowing current acted upon the surface of these blades, and as the chain was endless, some blades passed into the water at one end as others rose out of it at the other. The results, so far as efficiency was concerned, were decidedly disappointing, for with a current flowing at a rate of from 2½ to 2¾ miles per hour the brake horse-power developed by a machine which cost close on to £700 was little over 1 b.h.p. The price was, however, somewhat excessive owing to the novelty of the construction.

That the energy of flowing streams can be caused to produce rotary motion is obvious, as this type of motor is used in such rivers as the Tagus, the Rhine, etc., for grinding corn. So far, however, as the author is aware, the efficiency of these motors is very low, and though it may be raised possibly by more careful study of the most desirable form of blades, the size of the machines must always be very considerable for the power developed. The author's opinion is that such motors can only be of practical use where the current flows at a speed of at least four miles per hour, where the obstruction of such an apparatus in the channel is not objectionable, and where the water rental is very trifling or absent altogether.

(2) The second method—that of using a waterfall—appears at first sight very enticing. A country gentleman may have upon his estate a stream which either falls over a natural obstruction, or one having such a rapid fall in its bed that it lends itself to artificial means of producing a fall.

It is well in cases of this kind to have some instance in view. Upon a certain estate known to the author, a small stream ran down a narrow and steep ravine—the volume of the stream was, however, not very considerable. The owner of the estate was brought into communication with a firm of contractors, and they told him that his project to light his house by means of electricity was perfectly feasible, and that the small stream alluded to above would supply the necessary energy. Upon this assurance they secured the order to carry out the work. As there was no natural waterfall, it was found necessary to impound the water, and this was done at a point some 200 yards away from the house. Before obtaining the order, the contractors had remarked to their client that the works neces-

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sary to make use of the water power were but trifling and would cost, say, £100, but that the owner would be able to do this work himself much more cheaply than his contractors. It may be observed that no consulting engineer had been employed, but that the contractors were left to their own sweet will.

Originally a simple earth bank across the ravine was proposed to impound the water, and it was suggested that a wooden conduit should be fixed to suitable trees on the route, so that the water could be carried along a horizontal plane and arrive at a point over the course of the stream where the requisite fall could be obtained. It is needless to add that the work had to be done in a more substantial manner. Owing to a series of errors, the levels were wrongly taken, and the necessary fall could not be obtained without excavating for the tail race through rock to a depth of some 14ft. A turbine was then installed and geared by belting to a dynamo placed in a small shed above. The expense incurred by the owner of the property in constructing the dam across the ravine, forming the wooden channel, and excavating the tail race was about £700, or seven times that suggested by the contractors as the probable cost.

Let us now see if the results have been such as to compensate for the initial expense. The water supply is totally inadequate, as the water used by the turbine is vastly in excess of that supplied by the stream to the reservoir; in fact, even in very wet weather there is not sufficient water to drive the dynamo sufficiently long to do the necessary work.

Here, then, is a clear case in which a large expense has been incurred without any adequate result. A secondary battery is installed at the house which could be charged during certain hours, when there was sufficient water, and discharged to effect the lighting of the premises.

In such a case as this it would have been far preferable to have put down an oil-engine close to the house. The plant, as it stands, has given light to the house possibly for three hours a month since it has been put down. The hurry to get hold of work at any cost, and to put in a price which is in appearance low, seems to induce certain contractors to undertake impossibilities. Because a mountain stream appears in wet weather to give a considerable volume of water, they are led to promise the production of energy exceeding by perhaps 10 times the possible output. The result must necessarily be disappointment to both parties and great injury to the electrical industry generally, besides serious loss of status to the contractors themselves.

Even supposing there be on the average sufficient water power to keep the plant running, it is practically impossible to make use of it at such a season as we are now passing through; the reservoir is frozen over and is useful for skating parties, but it is impossible to use the plant at all. To put down an oil-engine or a steam-engine as a stand-by, is to duplicate the whole plant and double the cost; and it therefore appears very undesirable to hurry into the proposal of the use of water power for comparatively small outputs without very carefully weighing the *pros* and *cons*. The fact that water power is present without any rental to pay, appears often to blind people to the difficulties in the way of applying it.

To the amateur engineer nothing appears easier than to use the energy of the tides, of running streams, and other sources of Nature, but the great cost of the permanent works in many cases raises a practical obstacle to the successful carrying out of such undertakings.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 14.

MR. R. E. B. CROMPTON (President) in the chair.

At last night's meeting of the Institution the following candidates were balloted for:

Foreign Member.—Julius Martin, 16, Oak-street, Newark, New Jersey, U.S.A.

Associates.—Nigel Harington Balfour, 36, Cranley-gardens, London, S.W.; George Sydney Flood, 17, Delafield-road, Old Charlton, S.E.; W. E. Groves, 49, Hagley-road, Edgbaston, Birmingham; Alfred Ingram, Durham-road, Seaforth, Liverpool; Alfred Jacob, 50, Parliament-street, S.W.; Gerald Graham Palmer, Barton-under-Needwood, Burton-on-Trent; Walter Pethybridge, 183, King's-road, Chelsea, S.W.; Percival John Pringle, "Moringside," High View-road, Sidcup; Henry Walker, 11, Oxford-terrace, Gateshead-on-Tyne.

Students.—Bruce Charles Bouquet, 54, Graham-road, Dalston, N.E.; Frederic William Close, May Lodge, Leytonstone-road, Stratford, Essex; Walter James Coles, Finsbury Technical College, Finsbury, E.C.; Henry Thomas Constable, 105, Portobello-road, Notting Hill, W.; Urban Baly Gilbert, 3, Culverden-gardens, Tunbridge Wells; Ernest Herbert Lanham, City and Guilds Technical College, Finsbury, E.C.; Charles Histerman Merz, 38, Portland-street, Lincoln; Henry Joseph Norton, Finsbury Technical College, Finsbury, E.C.; Harold Yarington Packard, Finsbury Technical College, Finsbury, E.C.; Archie Corbet Seaton, Seaton House, Humber-road, Westcombe Park, S.E.; Harold Langton Tyson-Wolff, 166, Victoria-street, S.W.; Frederick Morier Walker, Faraday House, Charing Cross-road, W.C.; Frank Wilson, 162, High-road, Lee, Lewisham.

The following paper was then presented:

Reversible Regenerative Armatures and Short-Air-Space Dynamos.

BY W. B. SAYERS, ASSOCIATE.

The subject of the present paper is the development of the commutating device for continuous-current dynamos which I had the honour of bringing under your notice two years ago, and which has since been put into practice to a considerable extent by Messrs. Mavor and Coulson, of Glasgow, and other firms. It will be remembered that in my former paper I described a machine the armature of which generated its own field, the usual field magnets being replaced by simple C-shaped iron blocks, which Lord Kelvin, on viewing the machine, at once appropriately called "keepers." This property of a generator armature, when commutated on the backward lead, of producing or augmenting, as the case may be, the effective magnetic flux may, I think, be correctly described as a regenerative property, and I therefore propose to call armatures capable of being so commutated "regenerative armatures."

REVERSIBLE REGENERATIVE ARMATURES.

It was found that in many cases it was a serious drawback to machines constructed with regenerative armatures on my plan that they could only be run in one direction; in other words, the device was not reversible without structural alterations in the armature. I found a solution to this difficulty, however, in the construction shown in two diagrams presented to the meeting. In these figures there are represented two sections of the main winding of a drum armature—a commutator coil, which is connected to the main winding at the junction between the coils mentioned, and a commutator blade. The direction of winding is the same in the two figures, but in the first the direction of rotation is represented as being clockwise, while in the second it is counter-clockwise. A little study of these two diagrams will show that the commutator coil acts in precisely the same way in whichever direction the armature rotates, the brushes being always set with a backward lead, so as to bring the side of the commutator coil which is behind the point of connection to the main winding under the edge of the flux horn. In both cases only one side of the commutator coil is operative, the other side being in a position in the interpolar gap where normally there is no effective field.

I do not propose on this occasion to take up time with a minute description of the action of this device, the action of the reversible form now described being substantially the same as the simple form described in my earlier paper. In a few words, however, I may say the effective part of the commutator coil is still well under the flux horn when the commutator bar to which it is connected comes into contact with the heel of the brush, while the commutator coil immediately preceding it, which is under the brush and momentarily carrying the full current, is just passing out of the field, and consequently is the seat of a weaker and rapidly falling E.M.F.; the result of which is that the current flowing from the main winding is rapidly transferred to the more backward coil, which is still in the strong part of the field, and so is the seat of maximum E.M.F. In this way a third commutator bar comes under the heel of the brush, the action already described is repeated, and so the commutation proceeds.

I do not know whether it has been generally noticed that a close analogy exists between the problem of sparkless commutation and the problem of preventing knocking in a high-speed engine. In the latter case the valve must have a certain amount of lap and lead in order to give a sufficient compression and put on the live pressure at the proper time to just bring to a stand the motion of the connecting-rod, piston, etc., at the moment the crank is on the dead centre, and to restart them in the opposite direction. Just as the inertia of the reciprocating parts of the engine must be overcome by the steam pressure and not by the crank action, so the reversal of the current direction of the armature sections against the self-induction (the electrical analogue of inertia) must be overcome by internal E.M.F.'s, and on no account by the make-and-break action of the commutator plates and brushes. I think the analogy between these two things is strikingly complete.

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Auxiliary Devices.

In the simplest form of reversible machine only half the length of the commutator coil is effective in producing the reversal when the armature is running in a given direction. A means, however, of bringing both sides of each coil into operation was shown in a third illustration. In this case there is provided a pole-piece forming an extension of the flux horn, leaving a recess having an angular breadth approximately equal to, or a little greater than, the angular width of each commutator coil. The commutation is effected in this recess. It will be seen that the same action as has already been described takes place with regard to the part of the commutator coil which is behind the plane of commutation; but, in addition to this, the forward part of the coil next in front—in which the current is falling—has come under the polar extension, and as the field under this extension is of the same direction as under the main portion of the polar surface, while the coil is cutting it in an opposite sense, this coil is the seat of a back E.M.F. which operates against the current in this coil, and so assists in producing the reversal of the main armature section, which is in series between the two commutator coils under consideration.

In designing machines with a polar extension such as I have described, it must be borne in mind that, as the flux conveyed by the extension enters the armature at a point past the plane of commutation, it is non-effective in generating E.M.F. as it enters and leaves the armature on the same side of the plane of commutation; it must, therefore, be treated as leakage, and provision made for this non-effective flux in the cross-section of the field magnets.

Number of Segments in Commutator.

The necessity hitherto found for using a large number of sections in the commutator, and of resorting to duplex or triplex winding in the case of large low-tension machines, ceases to exist when machines are designed on the lines I am describing, and the number of segments is governed practically by the difference of potential it is advisable to allow between adjacent commutator plates. Of course, it would generally be inadvisable to reduce this number sufficiently to make the current undulatory to an appreciable extent, unless for machines for arc lighting.

That nothing is gained by using a large number of sections in the commutator is easily found from theoretical considerations, and is borne out by experience. Consider a two-pole drum armature having 24 coils in series generating the E.M.F.—that is, a total of 48 coils. If we use a 48-part commutator, the time occupied in the reversal of an armature section will be one-forty-eighth of the time of one revolution. If, however, we use a 24-part commutator, the time occupied will be one-twenty-fourth. The reversing E.M.F. will therefore be acting for twice the time in the latter case, as compared with the former. In addition to this, in the latter case the angular distance between successive commutator coils is doubled, so that the one which is going out of circuit is farther away from the pole-tip, and so well out of the fringe; so that the reversing E.M.F. (which is always the difference between that generated in the coil going out of circuit and the coil coming into circuit under the brush) is greater with the lesser number of segments. And, again, whereas in the first case the opposing self-induction is that of one main section plus two commutator coils, in the second it is only two main sections plus two commutator coils—that is, less than double; and then, most important of all, the rate of change is only one-half in the latter case of what it would be in the former. The reduction of the number of bars in the commutator has the further advantage that it allows of the brushes bearing on a larger arc of the commutator surface, so that a smaller width of brush is necessary. It would not do, however, to reduce the number of slots, or tunnels, in the armature, and put two coils in each instead of one, as this would have the effect of increasing the self-induction four times.

Design of Slotted, or Tunnel, Armatures.

Just as the steam-engine designer makes his reciprocating parts as light as possible consistent with strength, so it is worth while to so design the slots, or tunnels, in an armature as to get the least amount of self-induction, and this is to some extent antagonistic to other desirable features in short-air-space machines.

In the first place, in order to keep down the self-induction, the opening at the top of the slot should be as wide as possible, consistently with its not exceeding the limit where appreciable loss would occur through eddies in the polar surface of the field magnets. The width of this opening, as stated in my former paper, should not exceed one and half times the air-space. I usually make it about one and a quarter times. Next, the number of conductors in each slot should be as small as consistent with considerations of cost of manufacture, though, as already shown, it is advantageous in many cases to make the number of commutator blades as small as possible—the conductors in two or more pairs of slots forming but one section of the winding. Some designs of slots which have given satisfactory results in machines made by Messrs. Mavor and Coulson were shown to the meeting. In one case was represented a plain slot with reversible commutator coils, the number of blades in commutator being equal to the number of slots in the armature core. There are thus two commutator coil wires and two main armature conductors in each slot. Of the two former, one only is in operation at a time, the second belonging to a commutator coil further back under the pole, and which has not yet come into circuit under the brush. In the second case was represented a slot having a groove planed near the top on each side, into which the round wire forming the commutator coil is slid. In this design the number of commutator blades is half that of the slots, and the alternate wires come into operation in succession, the wires intermediate between these belonging to commutator coils further back, and not in circuit for the time being. This design, in addition to advantages already pointed out, permits of the armature being a little smaller in diameter, and also requires no binding, the commutator coils effectively securing the main conductors in their position in the core. A construction adopted in an 80-kilowatt machine for direct coupling, the speed being 240 revolutions per minute, was shown to the assembly. This machine I shall describe later on. The number of commutator blades is one-half that of the slots, but equal to the total number of convolutions of main winding. Instead of the conductors at opposite potentials—*i.e.*, those connected at the time of commutation to the opposite brushes—being in the same slots as is the case in the other two figures, these are wound in separate slots, each convolution of the winding passing through slots which are one removed from being diametrically opposite. The result of this construction is that the self-induction of a main armature section is only about one-half of what it would be if there were two conductors in one slot, both undergoing commutation at the same time.

Parallel Running.

It is almost unnecessary to say that machines for running in parallel must not have a rising characteristic—at any rate, when combined with their driving power. I have made no experiment with direct-driven plants; but it is evident that if a combined plant running on the governors gives a falling characteristic, two or more such plants would run parallel, although the dynamo, when driven at absolutely constant speed, had a rising characteristic. Of course the characteristic is under the control of the designer, and, apart from questions of permeability of the magnetic system and relative magnetising powers of shunt and armature, depends upon the position of the plane of commutation relatively to the neutral plane.

The characteristic of an 80-kilowatt machine when driven at a constant speed was illustrated. This shows a rise up to 300 amperes, after which there is a gradual fall down to full load. If driven at a rigidly constant speed, or if coupled, or run from the same power supply, so as to both run at the same speed, two such machines would not run in parallel with safety. The characteristic, however, of the machine and engine combined, when the latter is running in its governors, was shown. The increase of speed with light loads is sufficient to transform the characteristic into a falling one, from which it results that two such separate plants would run in parallel perfectly. As I have already said, however, there is no difficulty about designing a machine to have a falling characteristic, even if driven at constant speed.

So far as my experience goes, there is not much inclination to run compound machines parallel in this country; but if it were desired to do so, the arrangement which suggests itself—a modification of the well-known method for machines with compound winding—was shown diagrammatically. There are two main brushes, set with a backward lead, and two small subsidiary brushes, set on the forward lead. Suppose one machine were started, and it were desired to connect the second one in parallel, the second machine would be started and its E.M.F. adjusted in the usual way; the small brushes on the first machine would then be put down; next, the two small; and after that the two sets of main brushes on the second machine. When connection is established between the two armatures at the four points and on the same side of the commutators, part of the current traversing the coils between the two planes of commutation will leave the first armature by the small brush and flow through similar coils on the second armature, just as the current from the series coils on compound machines splits up between the two series coils when they are first thrown into parallel in the well-known arrangement. The other brushes may then be put down and switches closed, when the small brushes on the forward position will give stability to the system, in the same way as the independent connection to the brushes keeps compound machines from any tendency to play into each other. Although I have not tried this arrangement, I think there is no doubt that it would work satisfactorily if it were desired to run machines with a rising characteristic in parallel. It is usual, however, in central-station work in this country to use shunt machines, and to control the current from each machine by means of a variable resistance in the shunt, and, no doubt, it will generally be pre-

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ferred to use machines with a slightly falling characteristic for running in parallel, so as to avoid all complications. I may point out that with short-air-space machines considerable regenerative power is required in the armature in order to get even a moderate fall in the characteristic.

Rocking Brush-holders for Reversing Motors.

For reversible motors the fact of the regenerative armature requiring a forward lead, instead of a backward one, allows of a very simple and reliable automatic arrangement for shifting the brushes on reversal of direction of rotation. The rocking arm carrying the brush-holders is mounted on the shaft and suitably bushed and lubricated so as to move freely. The friction of the brushes causes it to be carried round with the armature until brought up by stops which limit its travel in either direction. These stops are, of course, adjusted so as to keep the brushes in the proper position for sparkless commutation. Thus, the position of the brushes is automatically changed without any sparking, as during the time in which the brushes are travelling from one position to the other immediately after a reversal they do not move relatively to the commutator, but travel round with it until brought up by the stops; so that there is no relative motion of commutator and brushes until the proper position is reached, and consequently no sparking.

Constant-Speed Motors.

The question has been put to me from more than one quarter whether motors fitted with regenerative armatures would be self-regulating—that is, run at constant speed with varying load when supplied with constant pressure at terminals—because the ordinary shunt motor owes its self-regulating qualities to the back turns in the armature, which have the effect of reducing the flux, and so compensating, so far as speed is concerned, for the increased drop of pressure caused by dead resistance in the conductors internal and external to the machine. The reply to this question is, that while in the case of generators it may be inadvisable to reduce the air-space below a given value on account of the crowding up of lines due to the large armature reaction causing a diminution in the total flux, and so bringing down the characteristic, in the case of a motor this action can be taken advantage of and the air-space reduced to a safe mechanical clearance: the reduction of the total flux due to crowding up will then tend to compensate for drop of pressure due to dead resistance. So that in the case of a motor we obtain the happy concurrence of lightest weight and minimum cost with best regulating qualities.

Description of 80-Kilowatt Dynamo built by Mavor and Coulson—420 Revolutions per Minute.

Armature.

Diameter over all	21in.
,, core	17⅛in.
,, hole in discs	4¼in.

Total flux (effective), N=20,600.000.

The main winding consists of 72 bars solid copper, 1·33 by 0·2in., connected at ends by "butterfly" connectors. Each bar is placed in a separate slot, and the connectors join the first to the thirty-sixth bar at each end. Thus the two bars in each convolution are one division less than diametrically opposite. In this case the commutator, or reverser, bar which is just under the pole-tip is joined at the commutator end to the commutator blade. At the distant end it passes over to the slot seventh removed, through which it returns and is joined to the main bar, which lies in the slot third removed from it.

Magnets.—The magnets are of (so-called) cast steel, and each half is made in two parts, with a division between them, ½in. wide, parallel to the magnetic flow, in order to reduce the crowding up of the lines from cross-induction—thus carrying out Prof. Thomson's suggestion.

The polar angle is	120deg.
The air-gap	¼in.
The shunt winding consists of 325lb. of No. 12 wire.	
Number of turns	2,016
Resistance at 120deg. F.	10·7 ohms.
Current	9·35 amperes.
Ampere-turns	18,800*.

The weights are as follows:

	Cwts.	qrs.	lbs.
Magnets, steel castings, etc.	35	3	2
Magnet coils	2	3	17
Armature (shaft, core, and commutator)	20	3	15
Windings, main coils, reverser coils	4	3	12
Bearing, rocker, brush-holders, etc.	3	3	1

The characteristic of the machine running at constant speed was shown, as was also the characteristic when the engine to which it was coupled was running on its governors. The engine was built by Messrs. Belliss, of Birmingham, and their test showed an efficiency of $\frac{\text{E.H.P.}}{\text{I.H.P.}} = 86$ per cent.

While this test was being made, however, the shunt coils were coupled in parallel, with a resistance in circuit which dissipated 1 per cent. of the total energy. So that the real efficiency of the combined plant is 87 per cent.

* This means 9,400 ampere-turns in each limb of magnets.

Discussion.

A somewhat new departure was made by the paper being taken as read The author then gave some observations with a view to demonstrating the advantages of his system, and he also explained at length the drawings and diagrams in connection with his paper.

Mr. Crompton moved a vote of thanks to the author, and, in doing so, said that they all appreciated the question of the air-space design. In the ordinary short air-space designs there was trouble with the commutators, and Mr. Sayers, he thought, justly claimed to have solved the difficulty.

Mr. Andersen said that he had not had experience in his own work of short air-spaces, and he had not had an opportunity of seeing Mr. Sayers's machines running. He thought, however, that there would be difficulties in connection with them, such as hysteresis and eddy currents in the field. He wanted to know if measurements had been taken as to these. If the plan of the author worked well it would be generally adopted, save where shunt machines were required. (Here Mr. Sayers explained that one of the machines illustrated was a shunt machine, and that no reversal took place even with a rising characteristic.) Mr. Anderson thanked Mr. Sayers for his valuable details, such as particulars of weight, etc. The weight of magnets, steel castings, armature, shaft, core, and commutator, etc., came to 64cwt. for a machine of, say, 96 per cent. efficiency. An ordinary horse-shoe type machine on the same lines would weigh for these items about 84½cwt, Mr. Sayers thus having a saving of about 25 per cent. But Mr. Sayers in other respects would have more weight, and his machine, he considered, required far more labour.

Mr. Mordey objected to the introduction by the author of new terms, such as "keeper," for field magnets, and "regenerative armature." If the armature were different from other armatures, he thought the best name to give it would be the Sayer's armature. Where the word "blades" had been used he preferred the old term, sectors. Mr. Sayers's was a clever arrangement for machines which had to run in both directions, but there were points of objection, such as sparking.

Mr. H. A. Mavor stated that the machines described were not experimental, but that they were quite successful practically in all the directions indicated. With regard to parallel working, he had taken the opportunity of being present at some experiments with the 18-kilowatt machine, which was represented in the diagram on the wall. As far as his experience went, no difficulty had been experienced in switching in parallel. In fact, the engineer where the tests took place used the expression that the machine was waiting for its load, which it took up very easily.

Mr. H. Ravenshaw, whilst admitting that there was great credit due to the author, thought that the latter put his extra copper in the wrong place. The author placed it on his armature, and that was a bad mechanical job. Since Mr. Sayers read his first paper, the speaker had made some experiments with what were known as cross-field dynamos, and to which he referred by means of diagrams. He had wound the cross-field coils so that he could separately excite them. He did so to a certain amount of load, and then varied the current in the cross-fields until the machine did not spark; and then till it did spark, and next below sparking, and got readings. As a result the machine was got to work so that it worked absolutely without sparking.

Mr. Horace Parshall referred to some experiments which had been carried out in the same direction as the author's. Two of the machines of 1,000 h.p. and 2,000 h.p. respectively, were shown successfully in operation at the Chicago Exhibition, and they worked entirely satisfactorily without sparking. With regard to the weights adduced by the author, whilst they in some respects showed a saving, he somewhat doubted whether he had demonstrated an economy as compared with some recently-designed machines. For instance, the weight of the armature seemed to be excessive, as was also that of the copper in the armature.

Mr. W. B. Esson said that he used to make slotted armatures, but so far from the clearance being ¾in., it was only ¼in., and there was no trouble through sparking. Looking at the question from the point of view of the manufacturer, he would like to know how the Thomson machines compared with the size of the ordinary machine. The author had not explained the 80-kilowatt machine—whether the magnets were of steel; if so, they were expensive. Another point that struck him was the difficulty which would be experienced in the making of different sizes of machines, necessitating a frequent resort to the pattern shop, and consequent expense. It seemed to him that the cost of connecting up the extra coils and providing for them must add considerably to the cost of the machine. He would like some definite information on the matter.

Mr. G. L. Addenbrooke referred to the experiments made with the 80-kilowatt machine at Belsize, and stated that many of the machines of that type were working satisfactorily.

Mr. C. C. Hawkins bore testimony to the efficiency of the 80-kilowatt machine. He submitted that it would be interesting to have placed before them the efficiencies of the machines at full loads.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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ELECTRIC WELDING.

Whatever may have been the chief causes at work in effecting the result, it will be admitted pretty generally that the art of electric welding has not made very rapid public development in this country, and even to-day it is to be feared that two-thirds of those engaged in the electrical industry have little or no acquaintance with the theory and working details of electric welding by either of the two accepted methods. Still less, therefore, will be the experience or knowledge of this art amongst mechanical engineers, although it would, and must, prove of immense advantage to the latter in almost every phase of their work. We propose, therefore, to emphasise in these paragraphs the importance of welding by means of electric currents, and to show how advantageous and economical the process may be in the workshop, factory, or steamship. As for the causes that have hindered the development of electric welding, we do not touch upon them more than to say that some of them have been very real, and others more fancied than actual. Over-capitalisation and other erroneous methods of promotion may be responsible for much of the delayed progress; but so far as the Benardos system of arc welding is concerned, it would seem as though the desire had been to hasten slowly, to make absolutely sure of each step, and to claim nothing which might not be certain of fulfilment.

To judge from the particulars contained in Mr. Foster's long and interesting paper upon this subject just read before the North-East Coast Institution of Engineers and Shipbuilders, and published on another page in this issue, the time ought now to be ripe for entire confidence to be felt in electric welding when properly applied; and we cannot refrain from hoping that the growth or extended use of these processes may henceforth in a natural fashion be as rapid and profitable as the electrical industry could possibly desire.

It is not, of course, postulated that welding may be done by electricity at a merely nominal cost. So far from that, the outlay not only upon the necessary plant, but in working expenses also, must be *apparently* very heavy; and we can feel no surprise at engineers hesitating with regard to the adoption of such a process when they are informed of the actual horse-power required to make a given weld. But it must not be forgotten that this energy is employed usefully—that instead of being spread over a considerable space of time under the ordinary system of heating in a furnace and welding under the hammer, the whole process is completed in a few minutes, and therefore the amount of energy increases in proportion. There is, no doubt, a saving of time effected, to begin with, in electric welding, and although large amounts of energy are required for the actual work of welding, yet this energy is not spent or wasted during intervals of work, as it must be to some extent with the ordinary process. Not only does the electrical plant give out just as much energy as is required, but every detail has been so studied that the efficiency by means of storage, etc., shall be very high, whether the plant

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is being called upon or not. Although, therefore, it may seem costly to put down special plant of large capacity for welding purposes, the final result shows that an absolute and considerable economy is possible of easy attainment.

For special work of an intricate nature, where ordinary methods are practically unavailable, a process like that due to Dr. Benardos has many advantages. Its portability, or ease of application, should alone secure its adoption in numerous cases, as pointed out in Mr. Foster's paper. Take, for instance, a broken ship's crankshaft or propeller-shaft. Accidents of such a kind invariably require instant remedies, but the difficulties of repairing a screwshaft can only be realised by those who have had to work at huge masses of metal in a confined space. With a portable welding plant on board it should not be a matter of many minutes to suitably patch a shaft together so that easy steam may be kept up. The suggestion offered by Mr. Foster in his concluding paragraph with respect to a portable arrangement of this kind, moving from place to place for incidental work, is also of considerable value, and will doubtless be adopted. It serves, at any rate, to show the great range of application possible for such a system, whether ashore or afloat—for regular work or occasional repairs.

Coupled with the paper read some time ago by Mr. B. A. Dobson upon electric welding before the Institution of Mechanical Engineers, we are inclined to think that the particulars now given by Mr. Foster will serve to prove most conclusively that these processes are long past their experimental stage, and may now be relied upon for good and efficient as well as economical working.

KENSINGTON COURT STATION.

We regret to state that about 10 on Tuesday night a fire broke out in the offices of the Kensington Court central electric light station of the Kensington and Knightsbridge Electric Light Company. Unfortunately, a child of Mr. Holland, the resident foreman, was suffocated, but otherwise the circumstances are such that congratulations can be offered to the electricians concerned in the station. There was virtually no cessation in the supply of current, owing to the arrangements which had been made. There is another station at Chapel-street, Knightsbridge, which has not been directly connected with that at Kensington Court, though the connection could have been made in almost a nominal period had it not been for the severe frost, which prevented the connection-boxes being opened until they were thawed. Owing to the admirable structural arrangements of the Kensington Court station, the boilers and engines were saved, and the electrical supply was maintained. The accumulator-room was destroyed, and the fire was so fierce that the electrical engineers on the premises had to work under circumstances in which probably no central station has ever been run before. In fact, one of our representatives was informed that Mr. Crompton, who was fortunately at home at the moment in the neighbourhood, actually stuck to the switchboard until he was lapped by the flames. That consumers have not suffered by a large fire of this sort at a central electric light station shows the advantages of electric lighting over that of gas lighting. Had a conflagration of the same comparative magnitude taken place at a gasworks, the customers would have been left in darkness for an indefinite period.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC BRAKE COUPLINGS.

SIR,—I should feel sorry if any expressions of mine were to obscure traction matters for anyone, and therefore regret not making my note clear enough for Mr. Bushell. It is quite evident now that Mr. Bushell wanted some information as to electric circuit couplers between railway carriages. The best method—such, indeed, as would occur to anyone when asked to devise an appliance of this kind—is so simple and effective that I thought it derogatory to anyone's knowledge to give details. If Mr. Bushell follows his advice to me, and goes to one of the railway termini—London Bridge, for instance (L.B. & S.C.R.)—he will see plenty of these couplings used for lighting the trains, and obviously they might serve also for electromagnetic brakes. I fear I cannot plead ignorance of the ordinary air-brake arrangements; in fact, some amount of experience has enabled me to differentiate a Westinghouse from a vacuum, and both from any others—but, of course, that is common knowledge.

Mr. Bushell will find my address in the electrical directories if he wishes to communicate with me at any time. I must refer him to the late officials for news of the electric traction company which he names.—Yours, etc.,

London, Feb. 13, 1895. FRANK B. LEA.

REVIEWS.

Central-Station Book-keeping: With Suggested Forms of Account. By HORATIO A. FOSTER, M.Am.Inst.E.E. New York: The W. J. Johnston Company, Limited. 1894.

It is perhaps typical of the great difference between the systematic solidity of English methods from the very outset and the decided want of system too often characteristic of progressive enterprise in the United States, that the author of this book should find it worth while not only to discuss the subject, but also draw up as guides a series of model account forms which his readers may adopt, wholly or in part, for the proper conduct of their business. The main thing in America is to *build* an electric railway or put up an electric lighting station: the best methods of working and most convenient system of book-keeping, etc., may be, it is thought, developed soon enough when the business is fairly set going. Hence there arises a demand—and a large one, too, apparently—for advice and information of the type contained in this book. In this country, however, we should say that it has but little scope except as a mere record of book-keeping systems abroad. So far as central-station work is concerned, the accounts of English companies are usually modelled alike, and fall in with Board of Trade requirements. Manufacturing and contracting companies, and other such private business enterprises, are of necessity carried on throughout with careful book-keeping methods, if the desire is real and evident to make them prosperous, not to say keep them out of the bankruptcy court. Mr. Foster's book is, however, well worth careful study by all those engaged in the management of electrical enterprises, for it contains a considerable number of excellent standards, as well as ideas and suggestions which may well be adopted even for the solid and substantial systems of accounting that are general in this country.

NEXT WEEK'S NEWS TO-DAY.

A Madrid telegram, received yesterday, states that the steamer "Dacia" has successfully joined the two ends of the cable from Cadiz to the Canary Islands.

Do not forget that a ladies night of the Electro-Harmonic Society will take place on Friday next, the 22nd inst., in the banquet-room of the St. James' Hall Restaurant, Regent-street, W. There is an excellent

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programme, which has only reached us at the moment of going to press, and which will be given in our next issue.

Mr. Bryce, answering Mr. Wharton in the House of Commons yesterday, said that he hoped at the earliest opportunity to lay on the table the Bill he had promised for providing light railways. The sooner the better, Mr. Bryce.

In the House of Commons yesterday, Sir George Baden-Powell asked the Under Secretary of State for the Colonies whether he could give the House any further information as to the projected telegraphic cable across the Pacific Ocean. Mr. Buxton was understood to say that the negotiations were in progress, and it was not advisable at present to make any statement on the subject.

Another late comer is the announcement by the county of London and Brush Provincial Electric Lighting Company that Mr. Angus McLeod has resigned his position as managing director of the Scottish House-to-House Electricity Company, and that Mr. A. J. Lawson has been appointed by the directors as the engineer and manager. Mr. Teague remains resident engineer at Coatbridge. At the same time the registered offices of the Scottish Company have been removed to 49, Queen Victoria-street, E.C.

The half-yearly meeting of the National Telephone Company, Limited, was held yesterday afternoon at Cannon-street Hotel, when Mr. J. S. Forbes moved the adoption of the report, particulars of which have already appeared in our columns. He stated that it was necessary to provide a considerable addition to the reserve, in order to cover what might arise when the company's lease ended. Their capital was now £4,430,000, and it was important to bear in mind that their business involved the finding of ready money in anticipation of new subscribers. Every new subscriber cost about £40; and the additional capital of £134,959 was mostly spent in that way during the half year. They had nearly 600 exchanges scattered over Great Britain and Ireland. Lord Balfour of Burleigh seconded the adoption of the report, which was agreed to.

THE APPLICATION OF THE ELECTRIC ARC SYSTEM OF WELDING TO MACHINERY AND BOILER REPAIRS.*

BY HENRY FOSTER.

This subject was discussed on Tuesday evening by Mr. Henry Foster before the North-East Coast Institution of Engineers and Shipbuilders in a paper entitled "The Application of the Electric Arc to Machinery and Boiler Repairs," etc. The paper, of which the following is an abstract, was accompanied by numerous illustrations:

At the present time there are two principal systems of electric welding in successful operation, and each system possessing special features which render it more particularly adapted for certain classes of work than the other. Firstly, we have the Thomson-Houston system, in which the heating effect induced by the resistance to the passage of the electric current through the articles to be welded together, accompanied by a certain amount of pressure between the parts thus heated, is made to produce the required weld; and, secondly, we have the Benardos or arc system, in which the article to be operated upon is made to constitute one pole of the electric circuit, while a carbon pencil attached to a portable insulated holder, and held by the workman, constitutes the other pole, the electric arc—which is the heating agent of the process—being struck between the two poles thus formed. When steel or iron is being welded it is usual to make the carbon the negative pole, and the steel or iron the positive pole; but for other metals the poles are sometimes reversed. In welding lead, for instance, it is usual to work with the carbon positive.

In this paper the writer proposes to confine his remarks and illustrations exclusively to the Benardos or arc system of welding—which, having been considerably improved in detail during the last few years at the works of Messrs. Lloyd and Lloyd, Birmingham, at Newburn, and elsewhere, is now more generally known as "the improved Benardos system"—and more particularly to the application of this system to repairs of machinery, etc., done under his supervision. The method of working is a very simple one, and is practically identical in all cases. The only difference between the methods of working adopted by Messrs. Lloyd and Lloyd and those adopted at Newburn, is in the construction and arrangement of the resistances, and may be taken as generally illustrative of the methods adopted elsewhere, and shortly described as follows: At Messrs. Lloyd and Lloyd's Coombs Wood works, the welding plant is arranged as illustrated by Fig. 1. Here an ordinary lighting low-tension continuous-current dynamo is used, to the terminals of which a battery of Benardos accumulators is connected, and into which the current flows continuously. When the welding circuit is closed, the current flows from the dynamo and accumulators through a large regulating resistance, and by these means a discharge equal to about twice that of the capacity of the dynamo is available. In parallel with the terminals of the dynamo or battery as many

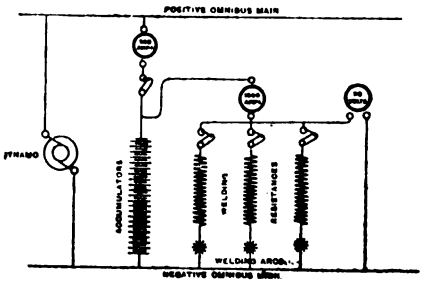

FIG. 1.

welders or welding machines as may be desired can be connected, and every welder is able independently to vary his current and pressure to suit the work in hand at the moment. One terminal of each welding system is connected by means of a flexible cable to a carbon pencil held in an insulated holder, which is in turn held by the workman, while the other terminal of the system is connected to the table on which the work lies or to the work itself. The special advantage of this arrangement of resistances and accumulators is that it admits of wide limits of variation of current and pressure to suit the different classes of work which may be in progress; and in the installation at Coombs Wood arrangements are made so that the works, offices, and foremen's houses are lighted, motors are driven, and the electric welding plant is supplied with current all from the same system of mains simultaneously.

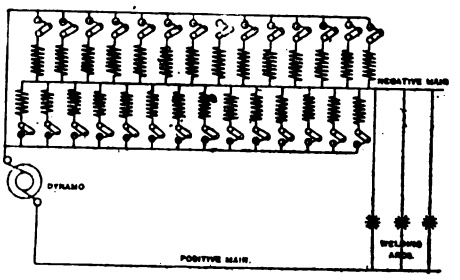

FIG. 2.

In cases where the current and pressure required for the work in progress are practically constant, and only welding is required to be done for the time being from the circuit, it is possible to work effectively without accumulators, providing large resistances are adopted, and this latter method of working, illustrated by Fig. 2, is that in use at Newburn. The efficiency of the method of working illustrated by Fig. 2 is not so high as that illustrated by Fig. 1, because during the time that welding is not being done the outer circuit is not closed, and no current is passing, consequently the whole plant is running light; but in a welding installation this defect may in a great measure be obviated by arranging two or sometimes three welders in the same circuit, and so arranging matters that when one man is welding the other one is dressing his work and making preparations for his turn. In any case, however, the method illustrated by Fig. 2 has the advantage of decreased first cost, and is more portable, and it becomes a matter of £ s. d. with each individual user as to whether the method of working as illustrated by Fig. 1, with its greater first cost and greater efficiency, or the method illustrated by Fig. 2, with its less first cost but proportionally less efficiency, is most suitable for the particular work to be done; bearing in mind that method No. 1 admits of a greater range of variation of current and greater length of arc being obtained than with method No. 2, and that with the lighter classes of work it is

* The shaded portion in the examples given in the illustrations indicates the nature and position of weld in each case.

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essential to use as long an arc as possible, because the heating effect is more regular and better distributed. The real object of this paper, however, is not to discuss the relative merits of the different methods of arc welding under special circumstances, but to show by a series of illustrations (1) what has been done by the method of working illustrated by Fig. 2, and

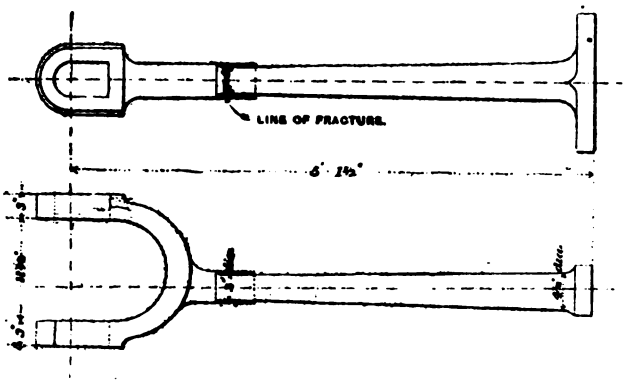

FIG. 3.

(2) to explain to those interested the simplest and cheapest method of doing similar work which the writer's experience would suggest.

GENERAL MACHINERY REPAIRS.

Fig. 3 represents one of the eccentric rods of the reversing engines which drive the plate mills at Newburn, and which was accidentally broken, as indicated, on August 13, 1891. The engines, which had only recently been erected, were being tested under steam (with a view to having all in readiness for the official inauguration ceremony in connection with the opening of the mills on August 15) when, owing partly to the sand and dust incidental to a new works, and partly owing to the negligence of the greaser, one of the eccentric straps seized, and the eccentric rod bent and broke close to double eye neck. The eccentric rod being of steel, and the position of fracture so awkwardly situated that it could not be readily welded in the ordinary way, it was decided to straighten the bent and broken rod and electrically weld it. This was done, and the engine with repaired eccentric rod attached was running again under steam at six o'clock the following morning. The eccentric rod as originally welded is still working, and has never since given the slightest trouble, although the engine in question has rolled every plate which up to the present has been made at Newburn.

Fig. 4 shows one of the steel roughing rolls for a bar mill, which under normal conditions works with heavy draughts on hard steel, and by which the wobbler end had been worn as indicated, until the coupling-box turned round without driving the roll, thus rendering the roll useless. The roll, which weighs over 50cwt., was taken out and the worn portions electrically welded up again to original size. The whole operation of taking out, welding, and putting in place again, only necessitated the mill standing for 24 hours. The welded roll has now been running for about six months, and although the wobbler is again wearing out, it is satisfactory to know that when it is again worn so that the coupling-box refuses to drive, the welding can be repeated again and again if necessary.

Fig. 5 shows one of a pair of cast-steel helical pinions, each weighing over six tons, for a large reversing plate mill. These pinions had to be taken out and the spare gear substituted owing to wobbler ends being worn, as indicated, by the constant reversing of the mill. With reversing mill pinions there is often a difficulty experienced in casting them of the exact hardness most suitable for the work. Either they are cast too hard, causing the pinion teeth to break before the wobbler ends are worn, or, as in this case, the wobbler ends are worn while the teeth are left perfect, owing to the steel being too soft. These wobbler ends were electrically welded up to the size originally made when new, and the pinions put to work again on January 28, 1895, and although since being welded they have not been working long, yet there is no need to anticipate trouble from the welding.

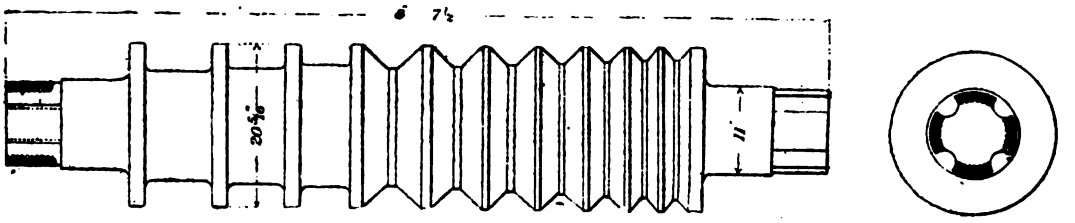

FIG. 4.

Fig. 6 shows the crankshaft of the small screwing engines fixed on the top of the plate-mill housings. The object of these engines is to turn the housing screws, and regulate the distance between the rolls, and thereby determine the amount of draught at each pass of the slab. The original eccentrics on these crankshafts were in halves and keyed to the shafts in the usual way; and so long as this arrangement existed, constant trouble was experienced, either due to the eccentric keys or bolts coming loose or to the eccentrics breaking. It was therefore decided

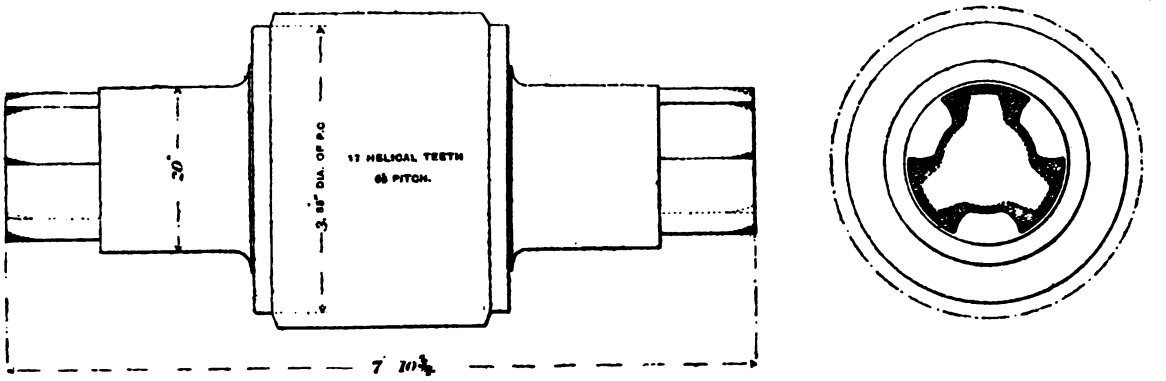

FIG. 5.

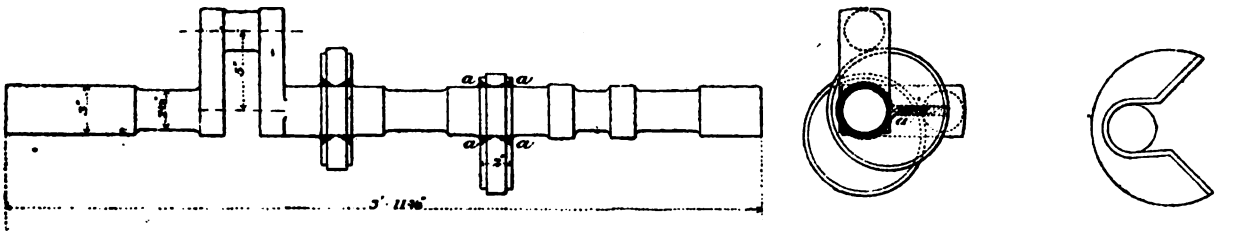

FIG. 6.

FIG. 7.

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to electrically weld new steel eccentrics to the old crankshafts, and this was done as follows: Rough slabs of steel were smithed to the shape shown by Fig. 7. These slabs were then heated red hot, and clasped round the shafts, and the V-shaped recesses, *a a*, electrically welded up to form the complete eccentric in each case. The shafts were afterwards centred in a lathe, and the eccentrics turned to finished shape in the usual way adopted when turning eccentrics on a solid shaft. Two exactly similar crankshafts had eccentrics fitted in this manner, and neither of them has given the slightest trouble, although the first one has now been working for nearly 12 months.

(To be continued.)

PHYSICAL SOCIETY.

The annual general meeting was held on the 8th inst., the chair being taken by the retiring president Prof Rücker.

The **Treasurer** (Dr. Atkinson) presented his report for the year 1894. The balance-sheet showed a somewhat larger expenditure than in previous years, the increase being partly due to the new system of publishing abstracts, partly to the rent of rooms and the expenses of tea. The balance in the bank had increased by about £33 during the year, but the treasurer said that, strictly speaking, the society had trenched on its capital to the extent of about £30, and that this would probably be the last report for some time to come which would show a balance in favour of the society. The assets of the society exceeded its liabilities by £2,642. 0s. 5d.

Prof. Carey Foster asked whether it would not be possible in estimating the assets of the society to make some allowance for the stock in hand?

Dr. Atkinson replied that that had not hitherto been done, and the difficulty would be to assign a money value to the stock. The stock of the works of Joule and of other memoirs was, of course, decreasing, while the sale of the *Proceedings* was becoming somewhat greater. As regarded the securities of the society, their actual value would be about £200 or £300 more than appeared on the balance-sheet.

Prof. Rucker said that the society had deliberately entered upon a policy of expansion, and that they must be prepared to find the expenditure increasing. On the other hand, it was hoped that by making the society more attractive a greater number of persons would be induced to join. In view of the great advantages now enjoyed by members, there had been some suggestion of raising the subscription, but in any case he thought that they might look forward to the future with confidence.

The report was then moved and adopted.

The next business was the election of officers and council for the year 1895-6, and Messrs. Rhodes and Yule, being asked to act as scrutators, collected the balloting lists.

Prof. Carey Foster proposed a vote of thanks to the Lords of the Committee of the Council on Education for having allowed the society to meet at the Royal College of Science. At the commencement of the life of the society its founder and first president, Guthrie, had obtained permission for the meetings to take place at South Kensington, and the society had continued to meet there until their recent migration to the rooms of the Chemical Society.

The vote of thanks was duly seconded, and was carried unanimously.

Major-General Festing then proposed, and **Mr. Croft** seconded, a vote of thanks to the auditors, Messrs. Inwards and Trotter. This also was carried.

Mr. Trotter then proposed a vote of thanks to the retiring council; they had shown an energy which was rare in such societies, and had inaugurated an active and original policy, which must prove of the greatest benefit to the Physical Society and to physical science generally.—Carried unanimously.

Mr. Elder gave notice of a proposed alteration of the rules, the object being to allow the council under certain conditions to admit persons into the society without requiring from them the usual number of recommendations from members. It was pointed out that sometimes eligible persons, especially those resident abroad, were unable to enter the society because they were unknown to any of the existing members. The motion to sanction the proposed alteration was put from the chair and carried, but this decision will need to be confirmed at a subsequent meeting, of which due notice will be given.

Mr. Rhodes then read the following list of the officers and council elected for the year 1895-6: president, Captain Abney; vice-presidents who have filled the office of president, Dr. Gladstone, Profs. Carey Foster and Adams, Lord Kelvin, Profs. Clifton, Reinold, Ayrton, Fitzgerald, Rücker; vice-presidents, Mr. W. Baily, Major-General Festing, Prof Perry, Dr. Stoney; secretaries, Messrs. Blakesley and Elder; treasurer, Dr. Atkinson; demonstrator, Prof Boys; other members of council, Mr. Shelford Bidwell, Prof. Crookes, Messrs. Fletcher, Glazebrook, G. Griffith, Profs. Henrici and Minchin, Mr. Swinburne, Profs. S. P. Thompson and S. Young.

Prof. Rücker then vacated the chair in favour of Captain Abney, and the meeting was resolved into an ordinary meeting.

Mr. S. Skinner read a paper "**On the Tin Chromic Chloride Cell.**" He said that his attention had been attracted to the cell by an account published by Mr. Case, of New York. The cell had been stated to give no E.M.F. at ordinary room-temperatures, while it gave a considerable E.M.F. at 100deg. C. The author had found that when the cell was directly connected up to a galvanometer there was no current at ordinary temperatures and some current at 100deg. C., but when he had measured the E.M.F. by Poggendorff's method he had found ·44 volt at 15deg. C., and ·40 volt at 97deg. C. The cell, as originally described, consists of a tin plate and a platinum plate immersed side by side in a solution of chromic chloride; when the temperature of the cell is near to 100deg. C., and the poles are connected, the following reaction occurs:

$$Cr_2Cl_6 + Sn = 2CrCl_2 + SnCl_2;$$

and when the poles are disconnected and the cell cooled, the reverse change takes place. The author prefers to use as electro-positive metal an amalgam of tin and mercury instead of a tin plate, so that when the tin precipitated during cooling falls to the bottom of the solution, it is redissolved in the mercury, and the cell has regained its original state. When silver nitrate solution is added to chromic chloride, only two-thirds of the chlorine comes down as silver chloride, and this has led the author to suppose that the proper formula for chromic chloride is $2CrClCl_2$. Hence he works out the electrolytic action by means of a Grotthus chain.

Prof. Rucker asked whether a change of polarisation would explain the behaviour of the cell at different temperatures.

Prof. Carey Foster asked whether the reversed chemical action on cooling from a high temperature were accompanied by a reversed E.M.F.

Mr. Skinner said, no; the tin was precipitated throughout the solution, and not at the surface of the tin plate, so that no E.M.F. of the kind was to be expected.

Mr. Appleyard thought that Prof. Minchin had used tin chloride cells with two tin plates for electrodes, the cells only working when one plate was illuminated.

Mr. Skinner thought that heating acted by removing an obstacle.

THE CANNON STREET EXPLOSION.

BOARD OF TRADE REPORT.

In our last issue we summarised the causes assigned by Major P. Cardew for the recent explosions in Cannon-street on November 10. We now give Major Cardew's report, which bears the date of December 4, 1894:

This enquiry occupied three days, the 19th, 20th, and 23rd inst. Mr. W. Russell Griffiths appeared for the Aldermen and Commissioner of City Police, Mr. E. A. Baylis for the Commissioners of Sewers, and Mr. R. W. Wallace for the City of London Electric Lighting Company. These gentlemen rendered great assistance in elucidating all the facts material to the enquiry. I append my notes of the evidence taken and also a transcript from the notes of the shorthand writer employed by the City authorities. Twenty-nine witnesses were examined, of whom 17 were present at the time of the occurrence, several of these having suffered injury and electric shock. The other witnesses were various officials of the company and experts. Among these latter, Mr. Foulger, chief distributing engineer of the Gaslight and Coke Company, gave very valuable evidence. I have prepared a diagram showing the positions of the principal points referred to in this report.

Description of System.

It will be of advantage to shortly describe the system of supply in use by the City of London Electric Lighting Company, Limited. This consists of a high-pressure alternating-current supply by means of concentric mains to converting stations, which, as a rule, have been constructed underground, and from these a low-pressure supply is given to consumers by distributing mains. The supply has until lately been given from two generating stations—one at Wool Quay, near the Custom House, and the other at Bankside, on the south side of the river. These stations were only intended to provide temporarily for the lighting, and a large permanent station has recently been constructed at Bankside and partly equipped with plant and machinery. The operations connected with the transfer of the load to the permanent station were being carried out at the time the accident occurred.

General Account of Occurrences.

It appears that on the 10th ult. about 1 p.m., a mare attached to a brougham belonging to Mr. C. Boutland, of 21 Cousin-lane, Thames-street, E C, was turning out of Cannon-street into Budge-row, when she pitched forward on her knees, then turned on her side and died in about four minutes. The driver, G. Clark, got down and immediately felt an electric shock in both legs. He was unable, on account of the intensity of the shock, to touch the mare, but disconnected the traces and backed the brougham clear. A warehouseman, named James Hutchins, who was at work in Budge-row, went to assist, but he also experienced a severe shock, and was unable to approach the mare closely. Shortly afterwards the iron lid of the street box opposite the Liberator Building Society's office was lifted about 2ft. in the air by an explosion, and thick smoke issued from the box. According to one witness there were three reports, each accompanied by a flash of blue flame. This street box is the one marked B. Two witnesses received severe shocks by stepping on to the street box cover on the opposite side of Budge-row. Apparently simultaneously with the explosion in Budge-row a more serious explosion occurred at the street box at the corner between Walbrook and Cannon-street, west side. In this case the lid was blown sufficiently high to be shattered by its fall, and the paving-stones in the vicinity were also dislodged. Several persons were injured by

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this explosion; in most cases the injuries received were only trifling. Two persons, however, I was informed, were unable to attend my enquiry on account of the injuries they had received. The veterinary surgeon who made a *post-mortem* examination of the mare stated that all her organs were perfectly healthy, and he could not account for her sudden death otherwise than as a result of severe electric shock.

The immediate causes of these serious accidents were—the breaking down of the insulation of a high-pressure main in the street box at the corner of Budge-row leading to the formation of a powerful electric arc between the outer conductor of this main and the end of the iron pipe, forming a conduit for the mains under Budge-row, which projected into this street box, and the consequent charging of this pipe to a dangerous extent; and the presence of gas in the electric light company's pipes and street boxes to an amount which formed a highly explosive mixture in the street box at Walbrook where the more serious explosion occurred, the gas being fired by the electric arc. It is true that Mr. Foulger, on behalf of the gas company, informed me that since the accident they had tested the soil in the vicinity of this street box, and had not detected the presence of gas in it, but, on the other hand, expert evidence was given of the actual presence of a highly explosive mixture of gas and air in a neighbouring street box, connected with it by means of several pipes, on the 19th inst. No gas was detected in the box where the explosion occurred at this test, but the cover of an intermediate box was loose at the time, thus providing a means of escape for the gas. On the whole, considering the nature of the explosions, the fact that one of them occurred at a distance of 26 yards from the electric fault, that the locality was admitted to be one where defects in gas-pipes had been rather frequent in consequence of the disturbance of the subsoil by the excavation for the completion of the Inner Circle Railway, and that no system of ventilation had been provided by the electric light company for their conduits, there can, I think, be no doubt that the explosions were due to the firing of an accumulation of gas in the conduits by the electric arc formed at the point where the main broke down.

The breakdown of the main was the consequence of a careless mistake, whereby an abnormal electrical pressure was brought upon the outer conductor, and this pressure found a point of weak resistance, probably a partial abrasion of the insulation, where the main was bent to enter the pipe leading from the box. The existence of mechanical injury to the insulation is almost a necessary postulate, since a piece of main containing the fault, now in my possession, shows the insulation to have been of ample thickness and first-class quality, and it should easily have withstood the maximum pressure to which it was on this occasion subjected. Indeed, I am informed that it had been tested with a much greater pressure.

The mistake that was made was as follows: Two new mains had recently been laid—one from the generating station at Bankside to Watling-street converting station, the other from Bankside to Milk-street converting station. It was intended to connect the Watling-street main into the new switching apparatus provided for it at Bankside, but the end of the Milk-street main was put in by mistake, while the end of the Watling-street main was left lying on the outer lead coating of another new cable. The end of this main was prepared to be put into its switch pillar and was not sealed up, as otherwise it should have been, and the inner conductor must have been very nearly in contact with the lead coating, and thus by means of the iron rack in which the cables were lying with the lead coatings of several other cables, all of which coatings were thoroughly connected to earth. While the Watling-street main was lying in this position instructions were sent to the foreman of the transformer department, Mr. Joseph McMahon, to switch the pressure on to it from the Watling-street converting station. As soon as he did this an electric arc started at Bankside between the end of the inner conductor of this main lying as above described and the lead coating adjacent to it, thus effecting a connection of the inner conductor of this main, and of the whole system of mains, to earth.

Now, in a concentric system of mains used for the transmission of alternating currents, under normal conditions the outer conductors are very nearly at the potential of the earth, and practically the whole working pressure exists between the inner conductors and earth. But a connection to earth of the inner conductors tends to reverse this condition, and raises the pressure between the outer conductors and earth. The inner conductor of the Watling-street main may have been absolutely touching the lead coating or "dead to earth" when first charged, and in this case the pressure between outer conductors and earth would have been raised to the full 2,000 volts at which the station was working. When the arc started in the street box in Budge-row, however, the pressure would be probably nearly equal on the inner conductors arcing to earth at Bankside and the outer conductors arcing to earth in Budge-row. The breakdown occurred in full daylight, so that the load on the station was comparatively light, and the sudden increase of current was at once noticed at Bankside, both by the powerful disturbance it caused in the telephone at which the engineer in charge of the station happened to be at the time, and by the peculiar noise, indicative of a short-circuit, made by the generating machines.

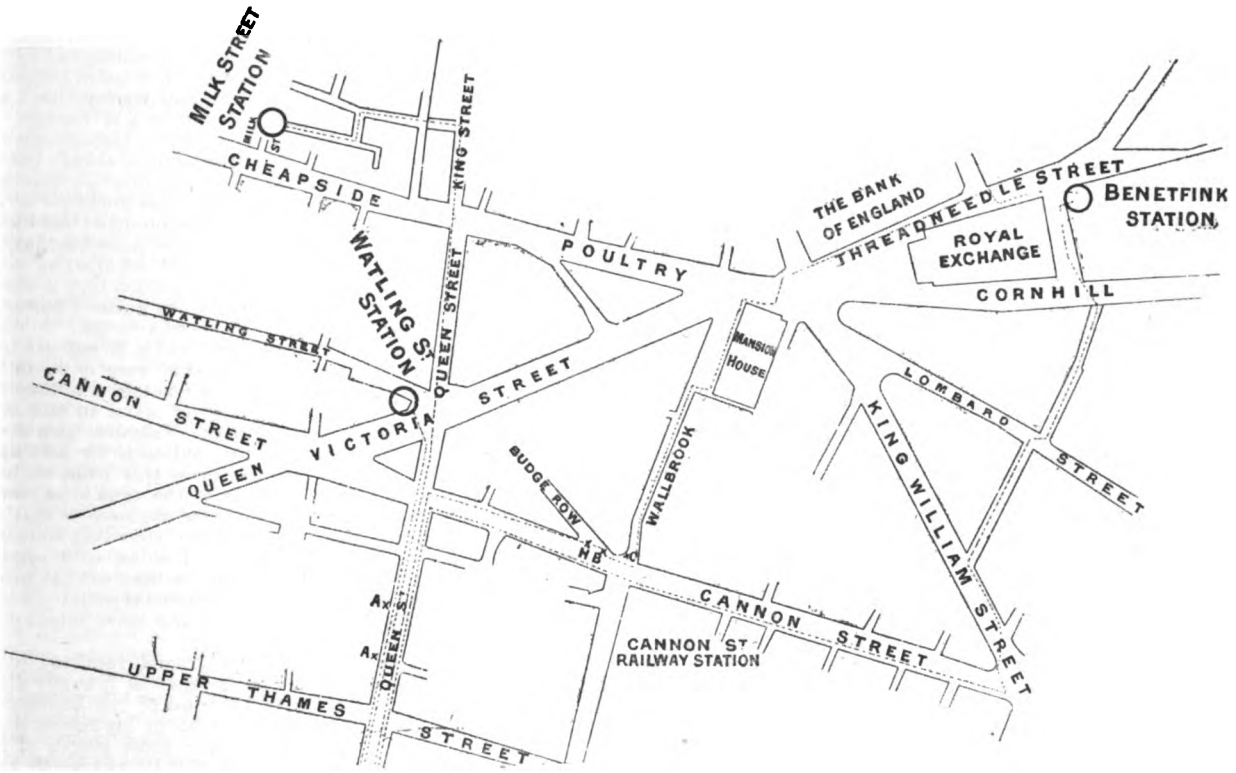

Diagram showing the principal points referred to in this report. Ax Ax are points between which the Watling-street and Milk-street mains were crossed. Bx shows the box where the earthing took place. C is the box where the explosion occurred, and Hx is the place where the horse fell.

Some of these generating machines were at once switched out of circuit, and the abnormal load thrown upon the only two machines left running caused such a lowering of pressure on the whole system that the lights are said to have gone out altogether. The foreman at Watling-street station noticed a flickering of the lights shortly after he switched the new main on, and suspecting that his action had in some manner occasioned a fault he at once switched it out of circuit. This was certainly the best thing he could have done, but it did not remove the fault, since the electric arc in the Budge-row street box had, of course, rapidly burnt away the insulation between the two conductors of the main and established an arc, or short-circuit, which still continued to burn furiously, melting away a considerable amount of both conductors. The engineers at Bankside in the meantime after consultation determined to switch off mains in succession until the fault was discovered, and by this means this fault was removed from the circuit.

Explanation and Comment.

Having thus given an outline of the occurrences, I will now deal more particularly with the points in which I consider the company and their officers and employés were to blame for want of judgment, carelessness, and inattention to the regulations

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imposed by the Board of Trade, and with the manner and means by which any repetition of such an alarming and serious accident may be avoided.

1. In the first place, it will naturally be asked, how was such an egregious mistake committed as the charging of one main under the impression that it was another? Bearing in mind that the pressure was one dangerous to life, it is evident that the consequences of such a mistake might easily have been fatal, since the end of the main that was charged might have been in a man's hand at the time.

2. Why, when the breakdown had occurred, since it certainly occasioned an excessive current in the mains affected, were these mains not automatically cut out of circuit?

3. Why, in the absence of proper automatic disconnectors, were there not at any rate some indicators to show the disturbance of potentials with regard to the earth and the rush of current through the mains affected; and how far might such indicators have prevented the breakdown or shortened the duration of the dangerous condition?

4. How was it that the surface of the street at Budge-row could become so dangerously charged in consequence of any defect in the electric mains; and how can this danger be removed?

5. Why was not the high-pressure main in the street box enclosed in strong metal casing efficiently connected to earth as required by regulation 7, *vide* Appendix II., since this box also contained low-pressure conductors?

6. Why was the accumulation of gas allowed to which the company attributed the explosion, and which they have themselves proved to exist in a neighbouring street box since the explosion?

1. The facts elicited at the enquiry with regard to this point disclose, in my opinion, great negligence on the part of some of those concerned. It appears that the two new mains to the Milk-street and Watling-street converting stations respectively run side by side down Queen street. The pipes to contain these mains had been laid some time previously, but the mains themselves were drawn in between October 9 and November 7, some delay having occurred during the progress of the work owing to the cables not being ready, and to alterations in one of the street boxes. The mains are drawn into the pipes in lengths extending from one junction-box to the next, the ends of each length are labelled to correspond, and the jointers subsequently effect the necessary joints at the junction-boxes. Owing probably to some obstruction met with, the pipes between two junction-boxes in Queen-street were to some extent twisted round each other so that their ends occupied different relative positions at the two boxes. The two mains were drawn in at the same time according to Mr. A Cook, the superintendent of cable-laying, and probably in consequence of the twisting of the pipes either the labels were wrongly applied on the ends of the cables at one side of one or the other of these junction boxes, or the jointers jointed ends marked "Watling-street" and "Milk-street" together.

There is a direct conflict of evidence on this point between the foreman in charge of the laying and jointing respectively, but I do not think it is necessary that the Board of Trade should enquire too minutely into the question of the exact proportion of blame to be borne by the various subordinate officials of the company. The main fact is admitted that between this point and Bankside station and in the station itself the main to Watling-street was labelled Milk-street, and *vice versâ*. It is not, however, so surprising that such a mistake should have occurred, considering that the mains were laid and jointed up at the same time, and that the engineer in charge had not apparently given very close personal supervision to the work, as that one of these mains should have been charged to high pressure and connected into an electrical circuit, the E M.F. in which was maintained by large engines and dynamos amounting to over 1,500 h.p., without previously identifying the main—that is to say, ascertaining by the very simplest electrical test—a test thoroughly understood by every telegraph linesman's assistant—that one of the cables brought into Bankside was in connection with the cable in Watling-street station, and which of the two it was.

This blunder appears to have been partly due to a misunderstanding between the superintendent of cable-laying and the electrician in charge of testing, but principally, I think, to the latter having made a report that the Watling-street cable was good without having ascertained that the rough test of insulation, which was the only test he had taken, had been really applied to the whole cable. Had he taken the precaution to test this by directing the distant ends of the main to be connected together so as to pass a current through the circuit thus formed, the wrong labelling of the two mains would have been at once discovered. It also appears to me that in a matter of so much importance the superintendent of cable-laying was too easily satisfied that the main was correct when he knew that only a rough test had been made, and that he might with advantage have been present when the main was switched on.

2. The answer to this is that the fuses inserted with the object of providing an automatic means of cutting any main out of circuit in the event of a breakdown required much too large a fusing current to be an effective protection, more especially since under the system of cross-connection of converting stations at present in use, the fault will draw current from each end of the main so that only a proportion of the current which is doing the mischief passes through either fuse. In this instance the main which broke down in Budge-row was protected at each end by fuses calculated to act with 700 amperes passing, and it was practically impossible for the generating power running at the time to actuate them. The reason alleged for the use of such large fuses is that up to the present time the whole supply has been given through a few mains, and any failure in one of these mains would throw an excessive load on the others. Fuses calculated on the normal maximum load for each main would therefore be insufficient to carry the increased working current in such a case, and a total stoppage of supply might result. Since, however, the maximum current intended to be carried by any one main is only 150 amperes I consider that the fuses used were far too large, even from the point of view that continuity of supply was the first consideration. The proper proportioning of fuses does not appear to me to have received due attention. The guiding principle seems to have been to take care that they were so large as not to cause inconvenience by acting.

It is at times of light load that large fuses fail to act, and I am of opinion that it would be a desirable precaution on all large mains used for high-pressure supply to use a small fuse for light loads and switch in a larger one before the time of heavy load. Of course, a reasonable margin must be allowed for possible unforeseen demands for current, and inattention might cause some trouble, unless the switching-in of the large fuse could be provided by automatic means, but the small fuse might be arranged to give warning when the current began to exceed its capacity. While on the subject of fuses I would direct attention to the omission on the charging of the new Watling street main of a very simple precaution, which had it been taken would certainly have prevented the accident—viz, to charge the new main in the first instance through a fine fuse wire. Had this been done the moment the arc started at the other end of this cable, the pressure would have been cut off

3. The observation of the potentials, with regard to the earth, of the two sides of an electric supply circuit is rarely provided for by electric light engineers, although it is a very important precaution, more especially in the case of high-pressure systems. Where the mains consist of separately insulated conductors, the occurrence of any fault of insulation is at once detected by the effect produced on their potentials, and the insulation resistance of the whole circuit can be obtained at any time without any stoppage of supply being necessary for purposes of testing. In the present case, where the mains are concentric throughout, and where the potential of the outer conductor should always remain nearly the same as the earth, any rise of potential on this conductor must indicate a fault and a dangerous condition of the circuits. Such a rise of potential must have occurred before the breakdown in Budge-row took place, and it is probable that if a simple indicator of such rise had been fixed at Watling street station and if the foreman there had been warned that it was an indication of danger, to be observed when any unusual operation was in progress, the accident would have been avoided.

Then, again, as regards the current indicators, it appears from the evidence that the engineers at Bankside were quite in the dark as to where the unusual current was passing, and they had to resort to the expedient of switching off mains in succession until they discovered which were affected. Valuable time would have been saved had there been a current indicator for each main to refer to. I do not however, wish to press this point too hard as the new switch-room at Bankside was at the time in an incomplete state. The evidence of the station engineer is that the faulty cable was cut out in 13 minutes; the recording voltmeter curves show a duration of 15 minutes. I think with suitable indicators and prompt action it might have been cut-out within one minute and had this been done the explosions would not have occurred, and possibly even the death of the horse might have been avoided.

4. The charging of the surface of the ground resulting in the death of a horse and shocks to human beings was brought about in identically the same way as in the case of the accident at Bournemouth on January 8 last, referred to in my report dated January 20, 1894. Here, again, there was a short length of iron pipe (about 37ft. in this case, 32ft in the Bournemouth case) terminating at the brick walls of the junction-boxes at each end, and not in metallic connection with the iron pipes on the other sides of these boxes. The depth of the pipe below the street level varied from 1ft. 4½in. to 2ft. 6in (about 18in. in the Bournemouth case). In this case it is true that the surface of the street was wood pavement, which might be supposed to offer considerable resistance to the passage of an electric current, but the weather had been unusually wet for some time before the occurrence, and the wood blocks and underlying concrete were no doubt thoroughly saturated with water and their resistance thereby diminished.

Since the Bournemouth accident I have carried out, with the assistance of the instructor in electricity at the School of Military Engineering, Chatham, some experiments to determine the rate of fall of potential on the surface of the ground produced by charging a pipe under similar conditions. The results of these experiments are detailed in a joint paper communicated to the Royal Society, and published in their *Proceedings*, a copy of which I attach to this report (*vide* Appendix I). They fully confirm the view I took of the nature of the Bournemouth accident which has been repeated in this case. The cause of the fatal shock to the horse and of the comparative immunity of human beings is fully stated in the report and paper above referred to. To remove this particular danger, the whole system of iron pipes enclosing high-pressure mains must be thoroughly connected together, and additional precautions, which are detailed below, should be taken to prevent any possibility of a discharge from mains to pipes. The duty of providing against this danger is distinctly imposed upon the company by Regulation 8 (*vide* Appendix II.), and they should not have permitted short lengths of pipes containing high-pressure mains to remain isolated.

5. I consider that there was a distinct failure to comply with Regulation 7, and I had previously brought this matter to the notice of the company. It had also been brought to their notice

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by the engineer to the City authorities. It happened that in this case the low-pressure conductors did not become dangerously charged, and they do not even appear to have been damaged either by the electric arc or the explosion, but the strong metal casing would probably have protected the cable against injury to the insulation, and even in the event of a breakdown would have much reduced the chance of accident by making a metallic connection from pipe to pipe across the street box. If an arc had been formed at all under these conditions it would have been a much smaller one, and time would have been given to cut off the pressure before the arc had eaten its way through the metal of the casing, or for the fuses to act, had they been sufficiently sensitive. The company now propose to encase the high-pressure mains across all street boxes by wrapping them with several layers of stout copper strip continued into the pipes at each side, and this precaution alone will, in my opinion, considerably reduce the risk of similar accidents.

6. The question of the accumulation of gas in the conduits and street boxes of the electric lighting company is the most difficult to deal with of all the questions raised by this accident. The danger is a well-recognised one and Regulations 14 and 15 (*vide* Appendix II.), impose upon the company the duty of efficiently protecting their conduits and street boxes against such accumulation. That this duty had not been adequately performed had been forcibly demonstrated by several previous explosions, of which particulars are given in the reports marked (*a*). One of these, the double explosion on January 8 last, was investigated by me, and the Board of Trade called the attention of the company to the fact that they were not adequately complying with Regulation 15. The company thereupon informed the Board of Trade that they were maturing a scheme of ventilation for their conduits. At this enquiry, however, it appeared that no means of ventilation had as yet been provided. What has been done is to keep two men constantly employed inspecting street boxes and reporting any accumulation of gas. These reports have been forwarded to the Gaslight and Coke Company, and in many cases the information thus supplied has enabled leakage of gas to be detected. Since the accident the number of men employed in opening street boxes has been increased to 12.

It certainly appears that up to the time of the occurrence of the recent accident the company had not displayed sufficient vigour in dealing with this very important matter, but it must be admitted as some excuse that there is at present some diversity of opinion as to how, in cases where the soil is heavily charged with gas by leakage from the gas-pipes, it can be best prevented from accumulating in the conduits of the electric lighting companies.

Thus, at the present enquiry, Mr. D. Cook, on behalf of the electric lighting company, gave particulars of a scheme of thorough ventilation which they were prepared to adopt, while Mr. Foulger, who appeared on behalf of the Gaslight and Coke Company, stated that in his opinion this system of ventilation would be dangerous, and General Webber gave it as his view that the pipes and conduits should be plugged at each street box to prevent percolation of gas, thus making thorough ventilation impossible. The company have a very extensive network of pipes occupied with their own mains, and they have also numerous spare pipes laid in communication with the same street boxes, and intended, I understand, to accommodate telephone wires. The whole length of their pipes and conduits exceeds, I am informed, 700 miles.

In my opinion, a system of thorough ventilation of all street boxes by natural or forced draught should be provided, and, in addition, everything possible should be done to prevent the entry of the gas by making the sides and bottoms impervious. Also the air capacity of these boxes should be reduced where practicable by filling them with incombustible material. At the same time the system of regular inspection should be continued, and immediate notice of any leakage of gas detected given to the gas company, who appear to take a very reasonable attitude in the matter, and expressed through Mr. Foulger their desire to render all the assistance possible towards the prevention of any further explosions. In the provision of ventilating pipes, it will be necessary to consider the possibility of the ignition of the gas issuing from these pipes. If they are attached to houses they should in all cases be carried up above all windows, and if they are erected in the streets the orifice should be at least 8ft. from the ground.

So far I have dealt with the immediate causes of the accidents and the mistakes made, but it is, I think, desirable also to draw attention to the fact that the work of the officials of this company has been lately carried out under very difficult conditions. The company commenced business with two so-called "pioneer" stations, and have erected and partially equipped the new generating station at Bankside, in order to be able to efficiently meet the rapidly-increasing demand for electric light. In this station nearly the whole of the plant and equipment is of novel design and unusual size and power, and the difficulties met with in the thorough testing and adjustment of this must naturally have been considerable. Before, however, the station was completed, before much of the plant had even been erected, still more before it could possibly have been thoroughly tested, and the adaptation of each part for its required action sufficiently studied by those who were to use it, the work of supplying electric energy to the City of London was thrown upon the new station.

The whole of the operations connected with the transfer of the load had to be carried out without interfering with the continuity of the supply, and at the same time the system of distribution mains was largely added to and remodelled. It is certain that in this transition stage risks were run—risk to the apparatus, risk to the employés of the company, and, as has been practically demonstrated, risk to the public. Here, I think, we have the real element of danger, which may, if not properly guarded against, occasion even more serious accidents. The same unfortunate experience has been the fate of other electric lighting companies. More especially are companies using a high-pressure system liable to become involved in the difficulties of a transition stage, since they are able to start with a very small capital expenditure, and yet carry the supply over a large district, picking up a customer here and there, while with low pressure this is impossible.

Requirements.

I will now summarise the precautions which should be taken by the company to prevent a recurrence of the accidents which form the subject of this enquiry.

1. In the first place, greater care is necessary in the testing and identification of new cables before connecting them to the high-pressure system.

2. Every new cable should be connected to the charged system in the first instance through a fine wire fuse, to be kept in circuit for at least two hours before any working current is passed through the cable.

3. Prompt action of the safety fuses should be secured by properly proportioning them to the working currents, and, if found practicable, by the use of more sensitive fuses at times of light load.

4. The interconnecting mains between converting stations should be kept out of circuit, except where in any case they may be absolutely necessary to maintain the supply, so that in the event of a breakdown of a main, current shall not be supplied to the fault from both ends, thus rendering the action of the safety fuses uncertain.

5. Suitable indicators should be provided at the generating and converting stations of the current passing in each main and branch connection, and especially of the pressure between the outer conductors and the earth, unless the company prefer to provide against the possibility of this pressure becoming large under any conditions by making an efficient connection of all the outer conductors to earth at the generating station. Of course, this can only be done with the approval of the Board of Trade with the concurrence of the Postmaster-General. This approval has been already obtained by the London Electric Supply Corporation and several other companies using concentric cables. Such an earth connection seems so far to have had no ill results, and it is certainly of great value in the interests of the public safety.

6. All high-pressure mains, where they pass through street boxes, should be enclosed in strong metal casing extending to some distance into the pipes at each side, so that the whole length of main shall be enclosed within metal which is in connection with earth throughout its length.

7. Accumulation of gas should be prevented by thorough ventilation, by making the sides and bottoms of street boxes impervious to gas, and by filling up the boxes as far as practicable with incombustible material.

8. Finally, while the company's arrangements for generation and distribution are still in a transitional stage, and while new and untried apparatus has to be brought into use, the very greatest care and the closest possible supervision are necessary. There is, I think, reason to hope that the company have now nearly completed the task of getting their system into proper working order, and if the precautions I have specified above are thoroughly carried out, I do not consider that there will be any further cause for anxiety as regards the public safety.

(To be continued.)

COMPANIES' MEETINGS.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED.

The ordinary general meeting of the above Company was held on Friday last at their offices, Richmond-road, Brompton, Mr. H. R. Beeton, the chairman of the Company, presiding.

The **Chairman**, in moving the adoption of the report and accounts, printed in our last issue, said that the business of the Company continued to show a steady growth, and the number of lamps connected during the past year was greater than during the preceding three years. The increase in the gross revenue was £1,452, and this had been earned at a reduced expenditure of over £400. The reduction in expenses was general throughout the revenue account, and testified to the more effective general supervision. The capital account showed an expenditure of £6,670, as compared with £7,409 during the previous year. Of this nearly £3,000 had been expended on new mains. This was, for the time being, a more or less unproductive expenditure. In view of the results now presented to the shareholders, the directors had under their consideration, in the general interests of the undertaking, the question of making a substantial reduction in the price of current to consumers. The Board were not yet in a position to make a definite statement in this respect, but they hoped that when the change was made it would not affect the net revenue, though it would affect the rate of progress of the Company. Since the issue of the report, the directors had not received the accounts which they had expected from the Leeds and London Company. The directors were disappointed that the business transacted under the agreement with that company had not been productive of profit, and they would investigate the causes. The Board felt that the satisfactory results which they were enabled to present to the shareholders

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were in large measure due to the services of Mr. William Page, the managing director, and Mr. Bowden.

The motion was seconded by **Mr. W. F. Leese** and supported by **Mr. W. Page**, and carried.

Mr. Beeton moved, and **Mr. Page** seconded, a motion that 7 per cent. be paid on the preference shares, and this was agreed to.

Messrs. Beeton and Page were re elected as directors, and Messrs. Theobald Bros. as auditors.

WATERLOO AND CITY RAILWAY COMPANY.

The second half-yearly general meeting of the shareholders of this Company was held last week at Waterloo Station, Mr. W. S. Portal occupying the chair.

The **Chairman** said that there was an expenditure of £6,163 up to June, 1894, and £5,269 during the last half-year, making together £11,432. There would be no further call during the current half-year, but there might be one in the subsequent half-year. A report up to date from the engineers mentioned that the contractors commenced operations by constructing a large timber stage in the River Thames, above Blackfriars Bridge, in which they had erected all their engines and machinery for the construction of the tunnels, including air-compressing machinery for driving through water-bearing strata, electrical plant for lighting the tunnel and running the excavations to the shafts. From this stage two large circular shafts, 16ft. in diameter, were sunk in the line of each of the tunnels, and the driving of the up tunnel in each direction was commenced on November 28. The material through which the tunnel was being constructed was the solid clay, entirely free from water, and in the Waterloo direction it had cleared the river, and was now underneath the wharf on the south bank. Towards the City the tunnel was also making rapid progress, and was approaching the northern bank of the Thames. Altogether 670ft. had been driven and lined with cast iron. The work was carried on without cessation day and night, except between six o'clock on Saturday evening and midnight on Sunday, and, so far, everything had gone on satisfactorily.

After some discussion the report was adopted.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

The ordinary general meeting of this Company was held at Cannon-street Hotel yesterday morning, Mr. S. W. Silver occupying the chair.

The **Chairman**, in moving the adoption of the report and accounts, which were published in our issue of last week, and the declaration of a dividend of 5 per cent. for the half-year, could not help saying that the directors were disappointed at the results after the hard struggles the Company had gone through, but they had suffered from the general depression in trade. Competition had increased and over-production had decreased profits. Also the condition of the money market and the low rate of interest caused people to be seeking investments in manufacturing business. Their cable steamers had been at a standstill. On the other hand, they had been able to buy material cheap. There were signs of a revival, but great caution was necessary, for a new system of doing business was coming into vogue which suggested losses as much as profits. Rates and taxes had been on the increase. The Company had tendered to the Canadian Government for the laying of 8,000 miles of cable from British Columbia across the Pacific to Australia, and they had reason to believe that their offer was receiving consideration. The directors were indebted to the Hon. Henry Marsham, one of the directors, who had offered to accompany Mr. Hamilton Gray in connection with this matter. The works at Silvertown and in France were highly efficient, and fairly well occupied. If the cable contract could be obtained and their steamers utilised, he hoped there would be a more favourable account of their labours in July next.

Mr. Robert Henderson seconded the motion.

The **Chairman**, in reply to questions, said that the reserve fund was invested in the business, that the stock bought below value was being used at the market price of the day, and that the result of the Pacific cable would be publicly announced.

The motion having been unanimously adopted, **Mr. Silver** moved, and **Mr. R. Henderson** seconded, the re-election of the Hon. Henry Marsham and Mr. A. Weston Jarvis as directors, which was agreed to. Mr. J. F. Clarke was reappointed auditor.

Mr. Matthew Gray, managing director, said he had visited the works in France four or five weeks ago. He found the whole place busy and the machinery in first-class order. There was no bother about strikes, and the men were doing their work very satisfactorily. The works were in better condition than they had ever been, and the work was being turned out well and at as cheap a rate as any works in France.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

The thirteenth half-yearly general meeting was held in Liverpool on Monday, Sir W. B. Forwood presiding.

The **Chairman**, in moving the adoption of the report and accounts (which were published in our issue of the 1st inst.), said that he believed the report would be satisfactory to the shareholders. From the report they would see that the gross revenue of the railway for the half-year ending December 31 was £25,700, and the profit, after deducting working expenses, amounted to £8,538. Out of this they had paid interest on their debentures £2,521, which left them £6,017, to which they had added the balance brought forward from the last half-year, £1,242, which made the sum available to be dealt with by them £7,256. They recommended the payment of a preference dividend of 5 per cent.—£2,428; also a dividend at the rate of 2 per cent. per annum on their ordinary shares, amounting to £3,750. This would leave a balance to carry forward to the next half-year of £1,087. In the half-year they had opened the north extension to Seaforth, and had also opened three new stations—one at Seaforth, one at the Langton Dock, and another at the Nelson Dock. Whilst they had derived increased earnings from that extension, there had necessarily been an increased expenditure. The train mileage run during the half-year was 314,472 miles, as compared with the same half of the previous year 243,539 miles, being an increase of 71,933 miles. They carried 3,641,397 passengers, as against 2,475,629, showing an increase of 1,166,000 passengers. When they originally issued the prospectus the directors were bold enough to say that they expected the traffic upon the line would be six million passengers per annum, but many people thought that in forming that estimate they were very sanguine. They were now glad to be able to report that the traffic had reached quite seven million passengers per annum. Nor did he think they had by any means reached the maximum of their traffic, because the more facilities they gave for travel the greater the traffic would be. Coming to their gross revenue, it was £25,675 as against £18,343 in the corresponding half of the previous year, showing an increase of £7,333. Their average receipts per passenger amounted to 1·61d., but he was glad to tell them that the last two months, since they made some readjustments in reference to return fares, their average receipts per passenger amounted to 1 91d. On the other side, their expenditure had been £17,162—that was to say, their working expenses—as against £13,732, an increase of £3,430. They had put an additional sum of £400 to the account of the cost of maintenance of ways and works. They thought this provision for the maintenance of the permanent way was very wise. The cost of the maintenance of their stations had also increased. The directors, he thought, were justified in taking the working of the line upon their own shoulders and terminating the contract with the Electric Construction Company. Comparing the expenses of their line with those of the City and South London line, he got the following figures. The working expense of the overhead railway per train mile was 13·10d., whereas on the City and South London line it was 15·36d. However, he thought it ought in fairness to be stated that with regard to the City and South London Company their stations were approached by lifts, and no doubt the working of the lifts added to the cost of working the line. Their locomotive expenses amounted to 3¼d. per train mile, as against 6·3d. on the City and South London line. The Liverpool Company had the advantage of a more economical system of motors than the City and South London Company, but he believed the latter company were about to adopt it. Taking the whole of their working expenses, they came to 66·84 per cent., but they hoped to see their way to make a considerable reduction and bring it down to 60 per cent. Although they had been running throughout the entire time trains every five minutes, 96 per cent. of their trains had been on time. The result was their line had become very popular. With regard to the southern extension, the directors thought that the time had arrived for it. The new line would be five-eighths of a mile in length. Starting about 200 yards on the north side of the Herculaneum Station, it would cross on iron girders to the foot of the Cheshire Lines goods yard, then proceed through a tunnel, emerging at the foot of Park-road, near the ancient chapel of Toxteth. They proposed to have a new station at the Dingle, which would be within a few hundred yards of Prince's Park, and a mile off Sefton Park. The engineers estimated that the cost of construction would be £87,000, and the cost of land, easements, and engineering expenses £10,000, showing a total of nearly £100,000. They hoped to be able to convey passengers from the Dingle to the pierhead in 12 minutes, thus beating all existing means. They had no intention of asking any further extension. With this addition the line would be complete, and it would not only facilitate the dock traffic, but would put them in communication with good feeders at both ends. As to how they would provide the necessary capital, it had occurred to the directors that by offering ordinary and preference shares in certain proportions they would make the issue attractive, and they believed that the shareholders would have sufficient faith in the undertaking to provide the capital without their having to go outside.

Mr. Richard Hobson seconded the motion, which, after some discussion, was carried.

A special meeting subsequently held approved of the construction of the southern extension railway, and authorised the directors to issue 7,500 ordinary shares of £10 each (being the unissued portion of the Company's original capital of 45,000 ordinary shares of £10 each).

LIVERPOOL ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Arthur Hill Holme (chairman), J. S. Harmood Banner, Samuel H. Holme, Sir David Radcliffe, Th. A. von Sobbe, J. C. Vaudrey, D. de Ybarrondo. Managing engineer: A. Bromley Holmes, M.I.C.E.

Report of the directors submitted to the shareholders at the ordinary general meeting of the Company held in Liverpool on Friday last.

The directors beg to submit herewith their twelfth annual statement of accounts, and are again able to report a steady increase in the demand for electric light. The total number of lamps connected to the Company's supply mains on January 1, 1894, was 25,784, and on December 31 31,792. The amount to the credit of profit and loss account, including the balance

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brought forward from last year, is £15,601. 7s. 4d. Out of this sum an interim dividend at the rate of 5 per cent. per annum was paid for the half-year ending June 30, and the directors recommend the payment of a dividend at the rate of 6 per cent. per annum, free of income tax, for the half-year ending December 31, 1894. They also recommend that the sum of £1,359. 5s. be added to the reserve fund, carrying forward the balance of £1,136. 8s. 10d. to next year's account. The expenditure on capital account during the year, including a proportionate charge for general expenses, has been £40,786. Considerable additions have been made to the plant at the Highfield-street and Oldham-place stations, and the mains have been extended where necessary to meet the demand. Applications for the light from the residential districts served from the Company's Lark-lane station have come in slowly, owing no doubt to the depressed state of trade, but the directors anticipate that in the future this district will form a very valuable section of the Company's supply area, without requiring any large capital expenditure. The shareholders are aware that under the Liverpool Electric Lighting Order of 1891 the Corporation have the option of purchasing the Company's Liverpool business as a going concern in the year 1898. On the enquiry by the Local Government Board as to the extension of the city boundaries, it was agreed that this date should be altered to the year 1900, and that the option should include the Toxteth undertaking also. The Corporation have approached the Board with a view to the immediate purchase of the Company's business, and as they have the right to acquire it at so early a date, the directors do not wish to adopt any obstructive policy, due regard being paid to the interests of the shareholders. The matter is one that naturally demands very careful treatment, and the directors would ask the shareholders to leave it for the present entirely in their hands. Should the Corporation offer terms which appear to the directors to be acceptable, the matter will be laid before the shareholders for their approval. Two directors, Mr. Th. von Sobbe and Mr. D. de Ybarrondo, retire by rotation, and, being eligible, offer themselves for re-election.

BALANCE-SHEET, DEC. 31, 1894.

Dr. Capital and Liabilities.	£	s.	d.
Capital subscribed—50,000 shares of £5 each	250,000	0	0
Reserve and renewal funds, including premium on shares	16,640	15	0
Sundry creditors	7,374	9	0
Amount due to bank	5,527	2	11
Profit and loss account—gross profit for year ending December 31, 1894 ..... £20,908 12 5			
Less depreciation £4,514 8 7			
Less renewal fund 2,500 0 0			
7,014 8 7			
Net profit for year ending December 31, 1894 ..... 13,894 3 10			
Balance brought forward from 1893, after deducting dividend and amount carried to reserve fund..... ..... 1,707 3 6			
15,601 7 4			
Less interim dividend for half-year ending June 30, 1894... 5,605 13 6	9,995	13	10
	£289,538	0	9

Cr. Property and Assets.	£	s.	d.
Freehold and leasehold land and buildings in Harrington-street, Highfield-street, Oldham-place, Rose-street, and Lark-lane £47,273 7 3			
Less depreciation on buildings 247 15 0			
47,025 12 3			
Additions since December 31, 1893 9,452 14 0	56,478	6	3
Machinery, mains, plant, etc. 177,267 17 10			
Less depreciation..... 4,187 1 5			
173,080 16 5			
Additions since December 31, 1893 31,239 4 6	204,320	0	11
Cost of Board of Trade license and provisional order 1,592 9 1			
Less amount written off..... 79 12 2			
1,512 16 11			
Additions since December 31, 1893 94 3 2	1,607	0	1
Stock-in-trade and contracts in progress	2,414	11	10
Sundry debtors	14,398	1	8
Cash deposited with local authorities.....	750	0	0
Investments, including cash on deposit	9,400	0	0
Cash in hand	170	0	0
	£289,538	0	9

The twelfth ordinary general meeting was held in Liverpool last Friday under the presidency of Mr. Arthur Hill Holme (chairman).

The **Chairman**, in moving the adoption of the report, stated that the Company had had a very good year, and that they might congratulate themselves upon increased business. It was gratifying to find that there had been a steady increase in the number of lamps used—an increase equal to 25 per cent. each year for the past three years. The total number of lights supplied by the Company now was 31,792, and that indicated that the Company was supplying a public want. Whilst recognising the interests of the shareholders, they had not forgotten the customers. When the company started they charged 1s. per unit, which was afterwards reduced to 8d., and subsequently to 7½d. If the Company progressed in the future as it had done in the past, they might yet be able to make a further reduction. He was sure that if they had about double the number of lights they now had, the price could be brought down to something like 5d. They would notice that the expenditure on capital account during the year had amounted to over £40,000. This was accounted for, amongst other matters, owing to the Company having put down more boilers and engines in Highfield-street and some machinery in Oldham-place. The Company had also bought land at both those places, and would therefore have proper room for any extension that might be necessary within the next three years. They had a station at Lark-lane which would be more useful as their system extended, and which at the present time was not a source of loss, although they did not derive profit from it. There was another matter in which they all took a deep interest—namely, the negotiations that they had had with the Corporation. They all knew that the City Council passed a resolution desiring to acquire the undertaking of this Company, and whilst some of the shareholders would probably think that it should be sold, others might think that it should not. However, he must ask the shareholders to leave the matter in the hands of the directors that morning, and say nothing that would give anyone a handle. The directors were giving the matter careful attention, and they and their lawyer, Mr. Radcliffe, had been in communication with the Corporation, and were quite willing to meet them in every way. He asked the shareholders to trust the directors not to sacrifice the property, and yet not to ask too high a price which would make negotiations impossible. So far as the Corporation was concerned, the Company had nothing to fear from them and very little to hope for. The Corporation had never helped them, and everything that they had done had been done in spite of the Corporation. In conclusion, he said that the Company was commenced under difficult circumstances; it had been developed with determination, and even if that should prove to be the final general meeting of the shareholders, owing to the Company being about to die, he thought it would deserve well of their fellow-townsmen.

Sir David Radcliffe seconded the motion, which was unanimously carried.

The **Chairman** moved the payment of a dividend at the rate of 6 per cent. per annum, free of income tax, for the half-year ending December 31, 1894. This was seconded by **Mr. von Sobbe**, and carried.

The proceedings were brought to a close with votes of thanks to the chairman and directors.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

The ordinary general meeting of the above Company was held on Tuesday at the offices of the Company, Carnaby-street, Golden-square, Mr. Eustace J. A. Balfour occupying the chair.

The **Chairman**, in moving the adoption of the report and accounts (which we published in our last issue), congratulated the shareholders on the fact that they were receiving 6½ per cent. on the ordinary shares, as against 4½ per cent. in the preceding year. They would require this year to face the question of an increase of plant, as they were near the end of their limit, owing partly to the fact that at Mason's-yard the full output was not obtainable, the Vestry having brought an action against the Company for a nuisance caused by vibration. They proposed to rearrange their machinery at Carnaby-street, and deal with Mason's-yard as the experts might advise. More debentures would be required, but he could not yet say when they would be issued. The cost of working had been reduced during the year by ¾d. a unit, which was creditable to the engineering staff. There had been a large increase in the rates, but the settlement of this matter would have to wait till the next quinquennial valuation of the Vestry. There was one danger ahead in the opposition of the Electrical Supply Corporation, which might reduce the rates so that they would not be remunerative. Efforts were being made to effect a friendly arrangement, and it was to be hoped that a friendly spirit would continue between them. The war of rates had not been commenced by their Company. After referring in appreciative terms to Mr. Kirby, who had resigned his directorship, Mr. Balfour said that during the present year there had been an increase of £1,500 in the gross revenue, they had 26 more customers, and the total number of lamps connected at the end of January was 76,610, an advance of 1,393.

Mr. Latimer Clark seconded the motion.

In reply to questions by shareholders, the **Chairman** stated that no money could be paid on founders' share until the ordinary shareholders had received 7 per cent. With regard to accidents, the Company had only had one, and that a very small one, due to an explosion of gas at the foot of St. James's-street. The Board of Trade and their engineer were seeking a remedy. However, their low-tension system could not produce a shock like the high-

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tension system. The subject of vibration at Mason's-yard was still being enquired into by the Board of Trade, and it was hoped that the difficulty would be solved.

The motion having been adopted, the **Chairman** moved, and **Mr. Fitch** seconded, the re-election of Mr. G. Balfour and Sir John Morris as directors, which was agreed to, as was the proposal to reappoint the auditors.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY, LIMITED.

The eighth ordinary general meeting of this Company, whose report and accounts were published in our last issue, was held on Monday in Newcastle, Mr. J. D. Millburn (chairman) presiding.

The **Chairman**, in moving the adoption of the report, said that the output of the Company in 1891 was 206,000 units, at a cost of 3·39 per unit; in 1892 it was 290,000, at a cost of 3·11 per unit; in 1893, 388,000, at a cost of 2·63; and in 1894, 431,239, at a cost of 2·45 per unit. Thus while the production had been steadily increasing, the cost had greatly decreased, till it had reached 2·45 per unit, which was the cheapest price at which electricity had ever been produced. As they went on increasing in production the cost would still further decrease, and they would have the satisfaction in time of making a reduction in the price charged to the customers. This continuous reduction in cost of production had not been achieved by any undue capital expenditure as, taking the capital expenditure of the Company in conjunction with the amount of electrical energy produced, it would compare most favourably with any company or corporation in the United Kingdom. The whole of the plant was in a thoroughly satisfactory condition, and it was pleasant to mention that the mains of the Company were in the best possible condition and quite as good to all appearance as the day when they were laid underground. Of course, there would have been some depreciation, but it was not apparent. There were miles and miles of cables, and they were most successful in the manner in which they laid down their tubes and the special joint-boxes. They had a special engine for blowing the air through those mains in order to keep everything perfectly dry and tight. They had great reason to thank the foresight of their managing director (Mr. Parsons) for that, for some of their neighbours had not been so successful in that respect. The condensing plant was doing all that was expected, and, as the operations of the Company increased, all the new machinery could be of the condensing type. In the course of the year they had had their shares quoted on the local stock exchange, and the present price of the shares was placed at a fairly satisfactory figure. The price of the light was cheaper in Newcastle than in any other place in England, and in a year or two they hoped to make it still cheaper. They hoped presently to derive a large income from electricity for cooking purposes. They had not yet got hold of the right motor for driving machinery, hoists, etc., but they believed the time was soon coming when they would get it, and then the finances of the Company would be in a considerably better state in consequence. With regard to the tramways, if the Corporation would allow them to run tramways with overhead wires, as at Milan, Genoa, and many continental cities, they could do it very well and cheaply, but they could not see their way to do it properly by an underground system. That was the reason, perhaps, why they had not taken the matter up. The Chairman then moved the adoption of the report, and that a dividend at the rate of 3½ per cent. for the half-year, making 6 per cent. for the year, be declared.

Sir Benjamin Browne seconded, and the report was adopted, the dividend declared, and Colonel W. M. Angus and Mr. J. B. Simpson re-elected directors.

An extraordinary meeting was then held, at which it was decided to increase the capital from £50,000 to £100,000.

The **Chairman**, in replying to a vote of thanks, paid a high compliment to the officials—Messrs. Parsons, Patterson, and Hunter.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Madrid.—The General Directors of Posts and Telegraphs invite tenders by 19th inst. for 1,000,000 rolls of telegraph paper.

Norwich.—The Town Council require by the 21st inst. tenders for the installation of the electric light at St. Andrew's and Blackfriars Halls. Mr. A. E. Collins, the city engineer, will supply specifications on application.

Weybridge.—The Urban District Council invite tenders for the public lighting of Weybridge on and after September 29. Tenders should state the number of public lights proposed, the illuminating power, and price per light. Tenders should be sent to Mr. Geo. Wheeler, clerk pro tem. to the Council, before 20th inst.

Islington.—Tenders are invited for the supply of alternate-current meters and converters by the Vestry of St. Mary, Islington. Specifications and full particulars may be obained on application to the electrical engineer, 50, Eden-grove, Holloway, N. Applicants will be required to deposit the sum of £1. 1s., which will be returned on receipt of a *bonâ fide* tender.

West Ham.—The Town Council invite tenders for a technical institute and public library in Romford-road, and invite designs for the same. Premiums of £250, £150, and £100 respectively will be paid to the authors of the designs which are placed by the assessor first, second, and third in point of merit. Particulars can be obtained on application to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, on payment of a deposit of £1. 1s., which is returnable. Designs by May 1.

Bury (Lancs.).—Tenders are invited for the supply of lamp-pillars, copper lamps, gas piping and fittings, and glass (perfect) for street lamps, for one year, for the Corporation. Samples may be seen and forms of tender obtained on application to Superintendent Geall, Fire Station Stanley-street. Sealed tenders, endorsed respectively "Lamp-pillars," "Copper Lamps," "Gas Piping and Fittings," and "Glass," to be sent to Mr. John Haslam, town clerk, Corporation Offices, Bury, by 20th inst. Preference will be given to those persons or firms who pay to their workpeople the regular standard rate of wages obtaining at the time in the town or district.

RESULTS OF TENDERS.

Walsall.—The tender of Mr. H. Gough, Dudley-road, Wolverhampton, at £1,750, has been accepted by the Corporation for alterations to buildings at the Wolverhampton-street gasworks, including the construction of boiler-house, dynamo-house, offices, and other works for an electricity generating station.

Wigan.—The committee appointed by the Town Council to invite tenders for electric lighting received the following offers:

Fowler and Co.	£7,931
Brush Company	6,985
Ditto (alternative tender)	8,243
Corlett Electrical Company, Wigan	8,721
Ditto (alternative tender)	8,547
Siemens Bros., London	7,133
Mather and Platt	8,820

The tender recommended for acceptance is that of Messrs. J. Fowler and Co.

South Shields.—The Town Council on the 6th inst. accepted the following tenders:

Black, Hawthorn, and Co., Limited, Gateshead, boilers and pipes	£1,809	0	0
H. Watson and Sons, Newcastle, pumps	905	14	3
S. Z. de Ferranti, Limited, London, engines and alternators	3,003	0	0
India Rubber and Gutta Percha Company, Limited, Silvertown, cables and trenching	4,846	0	0
S. Z. de Ferranti, Limited, London, arc lighting	793	11	0

The section for meters, etc., stands over for the present. The specification for this plant was issued last September. The borough electrical engineer, Mr. Jos. A. Jeckell, determined from the first that the plant to be accepted was that which afforded the best value for the money, and not because the tender happened to be the lowest. In order that he might have the means of comparing the respective merits of the different plants offered which fulfilled the spirit of the specification, irrespective of minor details, firms tendering were requested to submit along with their tenders drawings as per list appended to the specification, and for this reason the time allowed during which tenders were received was much longer than is usually the case. The leading firms submitted the drawings asked for, as it was evident to them that the plant would be considered on its intrinsic construction merits. The tenders accepted were those which in the opinion of the borough electrical engineer offered the best value for the money, and this opinion was endorsed by a sub-committee, consisting of four practical mechanical engineers, subsequently appointed to report to the Electric Lighting Committee on the tenders, and their report was unanimously adopted by the Council. It was decided to put down a rather larger plant than was at first thought of, and the engineer's estimate for this was accepted, and it was resolved to apply to the Local Government Board for leave to borrow £28,000.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,283.

Portrush.—The Watch Committee have decided to establish a telephonic fire-alarm system throughout the borough.

West Cowes.—The surveyor to the District Council has been requested to prepare a scheme for the electric lighting of the town.

Ossett.—A public meeting of the inhabitants of this Yorkshire town has been convened to consider the question of electric lighting.

Rothesay.—The Harbour Trust and Town Council decided on Monday to make enquiry as to the cost of adopting electric lighting at the harbour.

Bell's Asbestos Company.—A dividend of 10 per cent. is announced for the year 1894, £5,000 being placed to reserve, and £3,500 carried forward.

Lambeth.—A special meeting of the Vestry was called for last night to consider, among other matters, the question of abandoning the electric lighting order.

Newport (Mon.).—The Town Council decided on Tuesday to borrow £1,775 for the electric lighting of the Town Hall, markets, baths, free library, and museum.

Exeter.—It is proposed to light the art galleries at the museum by electricity. The matter is under the consideration of the Museum Committee of the Corporation.

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Dover.—The mains are now being laid at the turret on the Admiralty Pier. It is stated that the electric light will be adopted for the lighthouse at the pierhead.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 10th inst. amounted to £859, as compared with £691 in the corresponding week of last year.

Llanelly.—A report on the proposed scheme, estimated to cost £10,000, of lighting the town by electricity, has been prepared by the borough surveyor. Tenders are to be advertised for.

Great Northern and City Railway.—The capital of the Great Northern and City Railway Company not having been fully subscribed, the directors have decided not to proceed to allotment.

Hastings.—The Town Council have referred back to committee a suggestion that the electric light company should be asked to reduce the amount of the bill on the ground, as was alleged, that the lighting was a failure.

Parish Lighting Company, Limited.—This Company has been registered, with a capital of £15,000, to light with gas, electricity, or other illuminants, the township of Chester-le-Street, Durham, and the neighbourhood generally.

Westminster Electric Supply Corporation.—The ordinary general meeting of shareholders will be held at the offices of the Corporation, Eccleston-place, Eccleston-street, Belgravia, S.W., on Wednesday, the 20th inst., at 11 o'clock in the forenoon.

Mendota Steamship Company, Limited.—This Company has been registered, with a capital of £100,000 in £100 shares, to carry on the business of shipowners, as carriers, contractors for laying telegraph cables, and rendering salvage and towage services.

Folkestone.—Mr. F. H. Medhurst has inspected the district proposed to be electrically lighted according to the proposal of Councillor Baker. The scheme submitted by Mr. Medhurst is estimated to cost £19,000, including the erection of a dust destructor.

Bury.—The Town Council were unable last week to discuss the minutes of the Electric Lighting Committee, who reported that the borough engineer had submitted an exhaustive report on the various schemes and tenders submitted, together with a comparative table.

Monmouth.—It was mentioned at a meeting of the Town Council last week that Mr. Harris, of Messrs. Bramwell and Harris, the consulting engineers to the Corporation, was unable through illness to be present to discuss the sewerage and electric lighting scheme.

Luton.—The Town Council have received a letter from Messrs. Hayward Tyler and Howard, asking to be allowed to send in tenders whenever the Corporation proceeded with their plans for lighting the town by electricity. This has been referred to the Highways Committee.

Black Swan Gold-Mining Company, Limited.—This Company has been registered with a capital of £85,000 to acquire mining property in West Australia, and, among other business, to construct and maintain rail and tram roads, telephones, telegraphs, electric, gas, and water works, etc.

Electric Guest-Call Company, Limited.—This Company has been registered, with a capital of £5,000, to carry on business as manufacturers of and dealers in electrical machines and apparatus; in particular, the production of "announcing clocks" for use in hotels, clubs, and similar establishments.

Wakefield.—Mr. Lee mentioned at Tuesday's meeting of the City Council that it had been decided to engage Mr. R. Hammond as consulting engineer to the Corporation, and to apply for powers to expend £20,000 in carrying out the first instalment of the proposed electric lighting works for the city.

Maxim-Nordenfelt Guns and Ammunition Company, Limited. The general meeting of this Company was held on Monday, when the chairman, Sir Edmund Commerell, incidentally mentioned that the Company had gone into electric work, and that as far as it had gone it had been exceedingly good.

South Africa.—"R. M. B. 202," care of Messrs. Deacon's, Leadenhall-street, E.C., who is a mechanical engineer, is proceeding to South Africa, and is desirous of representing one or more first-class firms of engineers, boiler-makers, or electrical contractors who wish to introduce their manufactures into that district.

City and South London Railway.—The receipts of the Company for the week ended February 10 were £1,022, against £937 for the corresponding week of 1894, or an increase of £85. The total receipts for the current period of the present half-year are £6,041, against £5,727 in the corresponding period of 1894, an increase of £314.

Wandsworth, S.W.—The District Board of Works have resolved that in the event of the electric lighting company commencing works involving the construction of transformer-chambers under the public way in the district, the solicitor should be instructed to apply for an injunction to restrain the company from proceeding therewith.

South Barmouth Freehold Estates Company, Limited.—This Company has been registered, with a capital of £75,000 in £5 shares, for the acquisition of the estates of Ynysfaig and Penrhyn, in the parish of Llangelynin, county Merioneth, and to carry on business as builders, contractors, producers and suppliers of gas and electricity, etc.

Burnley.—In reply to Councillor Bayne, Alderman Collinge stated at a meeting of the Town Council last week that he could not hold out any immediate hope of a reduction in the price of the electric light. It had only just begun to pay its way, and he did not think there was another town similarly situated with respect to coal which charged less than Burnley.

Mining Plant.—It is stated that Messrs. Mather and Platt, Manchester, have now completed the erection of electrical plant at Spitzburg, for the Transvaal Gold Exploration Company, for driving 20 stamps of the Sandycroft type. Much interest is centred in this plant. The dynamos are actuated by a 22in. turbine of 60 h.p., supplied by Messrs. MacAdam Bros, Belfast.

Edison and Swan United.—An extraordinary general meeting of the Edison and Swan United Electric Light Company, Limited, will be held at the Cannon-street Hotel, E.C., on Thursday, the 28th inst., at 3 p.m., to consider and, if approved, to confirm as special resolutions certain resolutions which were passed at the extraordinary general meeting held on the 5th inst., and reported in our last issue.

Neston.—A meeting of the Neston and Parkgate Urban District Council has been held at which, with reference to the proposal to light the district with the electric light, Mr. Grenfell stated that he purposed making a canvass, with a view to finding out who would be willing to take the new illuminant, and eliciting any objections that might be raised, and thus find out whether the project was practical.

Primary Battery.—A non-polarising electric battery, the invention of Messrs. Walker and Wilkins, of Birmingham, has been inspected recently by a party of Liverpool gentlemen. On arriving at the works of the Patent Non-Polarising Voltaic Battery Company, at Springhill Wharf, Birmingham, the party were shown a number of applications of the battery to the production of light and power.

Redcar.—Mr. Bennett and Mr. Stacey, electricians, from Sheffield, have attended a meeting of the Urban Council to explain a scheme for lighting Redcar by electricity, and asking for a concession to lay mains through the streets, the cost to be not greater than the present price of gas, and the town to be at no capital expense. It was decided to hold a special meeting to consider and decide the question.

Edinburgh.—A sub committee of the Edinburgh Town Council had before it on Tuesday applications for extension of the electric lighting system in the South Bridge as far as the Surgeons' Hall, and in the North Back of Canongate. Some conversation took place on the question whether the low-pressure or the high-pressure system should be employed for such extensions, and it was agreed to get a report from Prof. Kennedy on the subject.

Leeds Tramways.—The special sub-committee appointed to prepare a report on the question of tramway haulage held a meeting on Thursday of last week, Alderman Firth presiding. Considerable progress was made with the report, and they expect to complete it at a future meeting. The reasons which have led the Tramways Committee to recommend the electric conduit system for the centre of the city, and the overhead electric system outside, will be fully explained in the report.

Fareham.—The opposition to the purchase of the electric lighting works by the town of Fareham has now reached its culminating point, for the Urban District Council has not only resolved to inform the Local Government Board that it does not desire to proceed with the application for sanction to borrow the necessary £7,000, but also refuses to sanction the payment of an additional sum of £150 to the company until the completion of their contract in September of next year.

Keswick.—The Chairman of the Urban District Council moved at a meeting of the latter that the Council adjourn for the purpose of receiving the reply from the electric light company. Mr. Pape moved, and Mr. Mumberson seconded, that the reply be considered at the next monthly meeting. The Chairman said if they did not agree to his resolution, he could get over the difficulty by calling a meeting by requisition. The Chairman eventually withdrew his resolution, and Mr. Pape's proposition was agreed to.

Clerkenwell.—The Vestry have received a letter from the Board of Trade, forwarding the copy letter they have addressed to the London County Council, on the subject of transformer-chambers, to which reference has previously been made in our columns. A letter was also read from the Vestry of St. George-the-Martyr, Southwark, expressing the hope that the Board of Trade will not adopt the recommendation of Sir Courtenay Boyle, contained in the foregoing letter. This was referred to the Parliamentary Committee.

Acton.—The Urban District Council have had under consideration the question of the advisability of assenting or dissenting to the application of the London United Tramways Company to the Board of Trade for a provisional order authorising them to extend their line to Acton-hill and conferring on the company certain other powers. A letter was read from Mr. Clifton Robinson on behalf of the company, and a deputation of ratepayers was heard in support of a petition in favour of the scheme. Another deputation was heard on the other side. Consideration of the matter has been adjourned.

City of London Electric Lighting Company.—Mr. J. Cecil Bull, the manager and secretary of this Company, informs us that the Board have resolved, subject to the completion of the audit, to recommend to the shareholders the payment of the following dividends for the past half-year: at the full rate on the 6 per cent. preference shares, and 5s. per share on the ordinary shares, being at the rate of 5 per cent. per annum. The transfer-books and register of members of this Company are now closed to the 27th inst. for the purpose of preparing warrants for dividends on the preference and ordinary shares.

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Ambleside.—A meeting of the District Council has been held, at which Mr. Hunter proposed that steps should be taken to oppose the Windermere and District Electric Lighting Company getting a provisional order. He thought it advisable to oppose the order, and followed by giving a number of quotations as to the cost of working the electric light, and showed that local authorities could do it cheaper. The Chairman said the question was one of opposition, and not so much the cost of working. A committee was elected to look into the matter.

Liverpool.—A meeting of the Special Lighting Committee of the City Council was held on Monday, Alderman Fred Smith presiding. No statement was made with regard to the rejection of the resolution by the Council at its last meeting, by means of which the special meeting convened for the consideration of the question of acquiring the Electric Supply Company's undertaking was countermanded, but the proposal to purchase the company's property was again discussed, and negotiations of an important character are in progress. The members of the committee do not think it advisable to disclose the nature of these negotiations at present.

Bath.—The Town Council have agreed, on the motion of Alderman Sturges, seconded by Mr. Knight, to pay the electric light company the £11. 5s. which might have been deducted because of the failure of one circuit of the light during November. Alderman Sturges said since the bill had been under consideration they had consulted Mr. Gatehouse, who gave it as his opinion that the failure was owing to the flood. The gas lights were out all over the city, and they thought it would be exceedingly ungenerous and unjust to make the electric light company pay while the gas company got off without paying a penny, while their lamps were not alight at all.

Manchester.—Alderman Gibson, in moving the adoption of certain recommendations at a meeting of the City Council last week, expressed the opinion that the Council had acted wisely in placing the gas and electric light undertakings under the direction of one committee; for otherwise these two enterprises, which in their separate spheres were capable of helping each other, would have become severe competitors. The committee proposed to reduce the price of the electric current from 8d. per unit to 6d. to small consumers. They also wished to do away with the charge for the hire of meters, and to lower the price of gas used for other than illuminating purposes.

St. Olave's, Southwark.—The Lighting Committee of the Board of Works recommend that the Board refuse their consent to the provisional order of the County of London and Brush Provincial Electric Lighting Company, Limited, in respect of the district of St. Olave's Board of Works. Mr. Fells moved the adoption of the committee's recommendation. Mr. Lafone thought it was essential that they should have competition for the electric lighting of the district, so that the light could be obtained at a reasonable price. At present they were paying anything but a reasonable price. Eventually it was decided to consent to the provisional order, subject to clauses being inserted to the satisfaction of the Board.

Southport.—The monthly meeting of the Town Council was held on Tuesday, when a long discussion took place on the minutes of the Electricity Committee with reference to the tender of Mr. Thos. Bridge to erect the extensions to the engine and boiler house of the electricity works for £1,897, which tender had been accepted by the committee, though a tender lower by £138 than this had been received. Councillor Hulme said that there were cases where the lowest tenders were the best. Alderman Hacking commented in severe terms upon the action of the committee, and said he would move that the lowest tender be accepted. Eventually it was decided to discuss the matter in General Purposes Committee.

Glasgow.—A complaint was made at a recent meeting of the Town Council by Mr. J. W. Dick, who asked if the same method of lighting was to be followed with the remainder of the tramway cars. Mr. Walter Paton said the electric lighting of the cars had not been so successful as they would have liked. They expected that the whole of the cars would have been lighted during the current winter, but they had found this impossible. Altogether, about 130 cars would be lighted, and the idea was that before the beginning of next winter the remaining 170 cars would be fitted up with the electric light. The point Mr. Dick had mentioned required consideration, and he had no doubt the committee would endeavour to bring about an improvement.

Hammersmith.—A discussion has arisen at a meeting of the Vestry with reference to a suggestion to light Uxbridge-road, from the centre of the road by electricity. Mr. Cramp condemned the suggestion, which he described as premature. Mr. Glasier agreed that it was premature to refer this matter to the Electric Lighting Committee, as it was not likely to effect an introduction of electric light into the parish for at least two years. Mr. Searle, referring to the tram lines, said there ought to be 5ft. between the two sets of rails in the centre of the road. If the lines were relaid as at present, and the Vestry decided to erect electric standards in the centre of the road, the rails would have to be removed. A proposition to refer this matter to a committee was lost.

Brighton.—The Lighting Committee have reported to the Town Council that they had instructed the manager to carry out the installation of the electric light at the swimming-bath in North-road. At a subsequent meeting it was resolved that two additional lamps be erected in Hampstead-road, and a letter from Councillor Fowler forwarding a memorial requesting that lamps may be erected in Edburton-road was referred to the borough surveyor. The proceedings having been moved by Councillor Stafford, Councillor Dell expressed anxiety to know whether proper precautions had been taken against the electric lighting wires and the gas-pipes coming into contact and occasioning explosions. The Mayor having reassured him on this point, the report was adopted.

Southwark Bridge Explosion. — Referring to the recent explosion on Southwark Bridge, Mr. George Livesey stated, at a meeting of the South Metropolitan Gas Company on Wednesday, that there had been an excavation beneath their main—formerly belonging to the Phœnix Company—which might have been laid for 40 years. Some work had been done by the City authorities to their sewers, and the main was excavated under, and was then left unsupported. This caused the fault to occur. The gas could not escape into the air, and probably it percolated through the loose earth into the electric light conduits. How it ignited, however, he could not say. He had mentioned this to show that the company were quite alive to these matters and the difficulties against which they had to contend.

Hawkshead.—The District Highway Board discussed last week some correspondence with the electric supply company, who, it was reported, declined to give any guarantee that they would lay a cable throughout the length of the Board's district. Mr. Marshall said that the request of the Board had been considered by the committee of the Rural District Council, but the Board's application came in rather late, and it did not appear that they were likely to receive much assistance. However, the promoting company had agreed to insert a clause to the effect that they shall, on the request of the owners of property in a district, within six months, lay down a distributing main through any part of the district, so as to offer a supply of electricity if the people give a guarantee for a period not less than three years.

Cheltenham.—A meeting of the Town Council has been held at which Mr. Norman, in proposing the adoption of the Electric Light Committee's minutes, explained that the delay in proceeding with the works was due to the weather. The committee could not afford to light the library free of charge. The committee, in addition to charging only £50 per annum for the supply to the library, were also prepared to pay any gas bill incurred through the failure of the electric light. Mr. Lewis hoped that the claimants for compensation owing to accidents due to the works would be met in a fair spirit, so that the Council should not be involved in any risky litigation. Mr. Norman, in closing the discussion, mentioned that the system for the first month would be worked at the risk of the contractors. Every precaution had been taken to guard against explosions. The minutes were confirmed.

York.—A question was asked by Captain Lindberg at a meeting last week of the York United Gas Company as to whether the directors had ever given any consideration to the question of procuring rights for lighting the city by electricity. Some four years ago the Corporation obtained powers of this kind, but up to the present nothing had been done. It would, in his opinion, be greatly to the advantage of the company if they obtained powers, as they would then have the entire management and control of the whole of the lighting of the city, instead of the Corporation having one portion and the company another. The Chairman said the directors were obliged for the suggestion. They did not turn a deaf ear to it, and in due course it would be attended to. There were legal difficulties in the matter, but it should have their consideration.

Queenstown.—The Town Commissioners met last week to hear a report from Mr. Hammond, M.I.C.E., on the practicability of lighting Queenstown by electricity. Mr. Hammond said he believed from what he had seen it would be practicable to light Queenstown most successfully, and at a reasonable figure. He believed it would be a great saving to the ratepayers of the town, as the price charged for gas was very high indeed. However, he presumed the Commissioners were anxious to see any scheme introduced a success, combined, of course, with economy, and he would be well pleased to give them any information he might possess on the subject. After hearing Mr. Hammond's views, it was decided that he should send a written report to the Board, and be consulting engineer if the scheme were adopted. Mr. Hammond then stated that he would visit the waterworks in company with their engineer, Mr. Campbell, to inspect the machinery at the pumping station, as well as to inspect the town generally, and he would send in his report on as early a date as possible.

Leeds.—The Yorkshire House-to-House Electricity Company announce a further reduction in the charges for current. Commencing on July 1 next, the price per Board of Trade unit will be as follows: when the consumption for the quarter does not exceed 1,500 units, 6d.; when the consumption for the quarter exceeds 1,500 and does not exceed 3,000 units, 5½d.; when the consumption for the quarter exceeds 3,000 units, 5¼d. These prices will be subject to discount based upon the number of hours per quarter during which the current is used, each consumer being called upon to declare the maximum number of lights required to be in use at any one time. The scale of discounts ranges from 5 to 15 per cent. In addition to the discounts accruing under this arrangement, a discount of 5 per cent. will be allowed on the net amount of accounts paid within one month from the date o rendering, and 2½ per cent. on accounts paid within two months. For heating, cooking, and power purposes current will be supplied at 3d. per Board of Trade unit.

Reading.—The Town Council have adopted a resolution referring to a committee the question of the best method of providing some uniform system for artificially lighting the entire block of

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public buildings, including the proposed new buildings for an art gallery and for the extension of the free library and museum. It is estimated that to light the whole of the buildings by electric light would cost £500 a year, and Alderman Messer stated last week at a meeting of the Council that it was a question whether for that sum they could not lay down their own plant. The Town Council intend to light the general market by electricity. The Reading Electric Supply Company announce that they will shortly be able to supply electricity to consumers occupying premises in the following streets: Broad-street, Blagrave-street, Butter Market, Caversham-road (to Vastern-road), Duke-street, Friar-street, High-street, King's-road (to Crown Bridge), London-street, Minster-street, Market-place, North Forbury-road, Oxford-road (to Howard-street), the Forbury, Vastern-road, and West-street. The charge for the electrical energy will be 8d. per unit.

Rochdale.—When the minutes of the Health Committee were under discussion at a meeting of the Town Council last week, Councillor Diggle enquired whether any action had been taken in regard to a suggestion in the minutes that the Electric Lighting Sub-Committee should promptly consider the question of utilising the surplus steam power at the sanitary works for the purpose of generating electricity. He also asked whether the putting in of new boilers at the sanitary works had been a success. The Mayor, as chairman of the committee, said the electric lighting question had yet to be considered by the sub-committee, which had not had a meeting since the suggestion alluded to was made The new boiler scheme had been more successful even than the Health Committee anticipated. Councillor Cunliffe said he did not think the Council fully appreciated the power available at the sanitary works since the introduction of the new furnaces. There was power enough now going to waste to enable the Electric Lighting Sub-Committee, if they would only come together, to light up the Town Hall, the esplanade, and the free library. The Mayor said this question had been put into the hands of a sub-committee, and he thought their report should first be awaited.

Wigan.—The committee appointed to consider the question of a supply of electric light have reported that invitations were sent to five firms to prepare a scheme with specification and cost of laying down electrical plant for the supply of current over one part of the borough. The firms were Messrs. John Fowler and Co., Leeds; the Corlett Electrical Engineering Company, Wigan; Messrs. Mather and Platt, Manchester; the Brush Electrical Engineering Company, London; and Messrs. Siemens Bros and Co., London. It was pointed out to the representative of the respective firms that, although the committee defined the area for an "immediate installation," there was every probability that ere long this would have to be extended. The committee have met on several occasions for the purpose of analysing and discussing the five schemes in all their bearings, and come to the conclusion to recommend the scheme as propounded by Messrs. Jno. Fowler and Co. as being the most suitable. The scheme recommended is based on the employment of the alternating-current system. Having decided on the scheme to be adopted, the committee have asked for instructions to proceed, or otherwise, with the preparation of drawings, etc., for the erection of boiler-house and boiler seatings, engine and dynamo house, with foundations for engines and dynamos, testing and store rooms, and offices. The Town Council have decided to apply to the Local Government Board for sanction to borrow £20,000 for the purposes of electric lighting. The tenders are further referred to in our contract columns.

Tunbridge Wells.—The Lighting Committee of the Town Council have reported that they have received an application from the National Telephone Company for permission to lay their wires underground in the trenches in which the electric lighting mains are to be laid, from Grosvenor-road to High-street. The committee have arranged that the company shall pay down a sum of £50 towards the cost of the trenches, and an annual rent of £5. The report was adopted. The committee also reported that they had held three meetings. The position of the arc lamps in the streets was provisionally decided. Messrs. Burn and Berridge wrote alleging that the electric lighting mains in London-road had been laid in small portions of the Common without permission. The town clerk was instructed to reply that the committee had throughout endeavoured to avoid any possibility of dispute with the manorial authorities, and had not laid the mains in any place requiring their consent. It was also decided, in view of future contingencies, to take counsel's opinion. Mr. Preece reported that he had selected sites for having transformer stations at Grosvenor-corner, Mount-pleasant, High-street, and Parade, and the surveyor was instructed to prepare specifications and invite tenders from local builders. Mr. Beale wrote suggesting that the mains should be extended as far as Eridge Station, and Mr. Hills asked for a supply in Crescent-road. It was decided that on completing the work in hand applications for extension should be favourably considered, and that the guarantee required for each extension should be considered on its merits.

Isle of Man Tramways Company.—The report of the Isle of Man Tramways and Electric Power Company, Limited, for 1894, states that the available profit from May 1 to December 31, including £526 premiums on shares sold, amounted to £11,034. Out of this an interim dividend of 6 per cent. per annum on the preference and 7½ per cent. per annum on the ordinary shares, amounting to £4,214, was paid for the six months ended October; £1,667 interest on debentures, up to the end of December, and £43 interest on mortgages (balance); making a total of £5,924. The directors recommend that a further dividend at the rate of 6 per cent. per annum on the preference, and 7½ per cent. per annum on the ordinary shares, for the remaining portion of the financial year ending December, amounting to £1,437, be now declared; that £2,000 be carried to a reserve and renewal fund; and that the balance of £1,673 be carried to profit and loss new account. Owing to unavoidable delays, the passenger traffic between Groudle and Laxey was not commenced until July 28, and this part of the line being the most important section, the profits are much less than what may be anticipated in future years. The passenger traffic on the electric line during the winter months has exceeded the expectations of the directors, who are confident that the revenue to be derived from goods and merchandise traffic will be substantial. Arrangements are being made to meet the wants of the districts through which the tramway passes, together with the surrounding neighbourhoods. After providing for the dividends on the preference and ordinary shares, and interest on debentures up to December 31, and carrying £2,000 to the reserve and renewal fund, an available sum of £4,080 over and above the balance carried forward remains in hand to meet any necessary outlay on rolling-stock, etc.

Cardiff.—During the consideration of the minutes of the Electric Lighting Committee at Monday's meeting of the Cardiff County Council, Councillor Trounce enquired how there came to be a loss of £3,500 in one year on the electric lighting works. He asked if anything could be done to increase the revenue. The Mayor said the committee was doing all it could in the matter to induce a larger number of tradesmen and others to adopt the new method of lighting, and it was hoped that the number of new customers would steadily increase. Councillor White moved that the appointment of Mr. Franklyn as engineer be not confirmed by the Council. The appointment must, in accordance with resolution, be advertised, and he proposed that it be advertised. Councillor Crossman seconded the motion. The Mayor said they had only half a load on the machinery, and it was too strong for the position, but when the load became greater the vibration which was now taking place would subside. He was so informed by Mr. Massey, their engineer, and he understood that Mr. Harpur confirmed him. Mr. Harpur intimated that he did not confirm the statement. The Mayor said they were in the awkward position of having no one in absolute authority at the works. There was a division of opinion between the engineers, and it was too much to expect Mr. Harpur, with his other duties, to attend to the electric lighting works. Mr. Franklyn had come down to take charge for Messrs. Siemens, who were putting in very valuable plant. The engineer they had appointed at £150 a year had declined the post, Cheltenham having paid its engineer £250 per annum. There were four engines, four engine drivers, and four stokers, but so far only two engines had been running. The committee must have a free hand to appoint someone who was thoroughly qualified, and they could not get such an engineer at less than £200 a year. The minutes of the committee on this point were referred back, and it was resolved that the appointment be advertised. On the motion of the Mayor, seconded by Councillor Good, it was resolved that the borough engineer and Mr. Massey prepare a full statement each with regard to the further improvements necessary at the works and with their own recommendations.

Bradford.—Mr. W. C. Dixon (chairman of the Gas and Electricity Supply Committee) moved the adoption of the minutes of that committee at Tuesday's meeting of the Town Council. Mr. Dixon asked the Council to sanction the purchase of two new engines for the electricity works—a matter that was not referred to in the minutes. He said that a sub-committee had unanimously passed a resolution in favour of getting two new engines, and he asked the Council for sanction to the proposal out of the ordinary course in order to save time. The electricity works were running at their fullest capacity, and it was urgent that the additional power should be obtained with as little delay as possible. Some time since arrangements were made to get two new boilers, which but for the severe frost would probably now have been at work. Unless the two new engines were obtained the money spent on the boilers would be practically wasted. He hoped the Council would pass the proposal. It would be two or three months before the engines could be got to work. Mr. James Kay seconded the motion. Mr. T. Crossland said that in two or three months they would be in the midst of summer, and he therefore did not see the necessity for hurrying the matter. Alderman Morley, Mr. R. Pratt, and Alderman W. Lister expressed the opinion that in view of the impossibility of getting the new engines to work till the year was much further advanced, it was unnecessary to hurry the matter through the Council. Mr. W. E. Aykroyd asked what kind of engine it was intended to order. Mr. Dixon said he did not think there was another electrical engineer in England who had been placed in such difficulties as Mr. Baynes. The department had been working from hand to mouth ever since the electrical station was started, and he wished to relieve Mr. Baynes of the unnecessary anxiety thus imposed on him. It would take a long time to get out specifications and get in tenders. The committee were not tied down to any particular class of engine. He had his own opinion as to the class of engine required, and at the proper time he would not hesitate to give that opinion. It would take the committee all their time to get the engines running by next winter, and Mr. Baynes assured him that before the summer was over he would have all the work which the present station would do. Six weeks ago there was a breakdown, for which it was claimed that the Corporation were responsible, mainly because there were no spare engines. He thought precautions ought to be taken for the future, and that some spare plant ought to be provided. Ultimately Mr. Dixon withdrew his proposition for the purchase of engines.

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PROVISIONAL PATENTS, 1895.

FEBRUARY 4.

2394. **Improvements in primary batteries.** Hymen Levetus, Edward Moses Levetus, and Walter Rowbotham, 47, Vittoria-street, Birmingham.

2430. **Improved means for insulating electric conductors.** George Gatton Melhuish Hardingham, 191, Fleet-street, London. (The firm of Felten and Guilleaume, Germany.)

2446. **Improvements in apparatus for the reflection of electric or other light applicable for use in connection with buoys at sea, signalling, advertising, and other purposes.** John Boyes, 124, Chancery-lane, London.

2450. **Improvements in the bulbs of incandescent lamps.** Alexander Leslie Fyfe, 22, Southampton-buildings, Chancery-lane, London.

FEBRUARY 5.

2492. **Improvements in submarine telegraph cables.** William Sharpey Seaton, 124, Chancery-lane, London.

2541. **Improvements in electric burglar alarms.** Lionel Herbert Hordern, 70, Chancery-lane, London.

2558. **Improvements in electric arc lamps.** Oliver Leopold Peard and Albert Essinger, 55, Chancery-lane, London.

2561. **Improved means and appliances for regulating the feed of carbons in electric arc lamps.** James Jeffryes and John Lea, 166, Fleet-street, London.

FEBRUARY 6.

2570. **Improvements in chandeliers, electroliers, pendant hanging lamps, and brackets for gas, oil, or electric light.** Charles Meason and Thomas Ford, St. Ives, Crompton-road, Handsworth, Birmingham.

2604. **Improvements in electric arc lamps and their connections.** Rookes Evelyn Bell Crompton, 55, Chancery-lane, London.

2606. **Electrical and pneumatic apparatus for scraping, cleaning, and lubricating the hulls of ships when afloat or in dock.** Alfred William Gatfield and William Richard Clark, 9, Station-terrace, Greyhound-lane, Streatham Common, London.

2650. **Improvements in electric bells or gongs.** Samuel Quincey, 567, Seven Sisters-road, South Tottenham, London.

2659. **Improvements in electrical resistances.** Sir Charles Henry Augustus Frederick Lockhart Ross, Bart., 6, Bream's-buildings, Chancery-lane, London.

FEBRUARY 7.

2675. **Improvements relating to insulators for overhead electrical conductors.** Arthur Wiglesworth, 10, St. George's-crescent, Liverpool.

2740. **Improvements in dynamo brushes.** Thomas Fryer and Albert E. Channon, 5, Hatton garden, London.

FEBRUARY 8.

2804. **Metallic mixtures and alloys for effecting electro-chemical decompositions.** Oliver Imray, 28, Southampton-buildings, Chancery-lane, London. (L. Diehl, Germany.)

2805. **To regulate or assimilate the movements of electrically-connected mechanical instruments or machines, more particularly wheels or other bodies revolving upon axes, and to diminish variations in the movements or speed of the same by means of electrical impulses.** Richard Joseph Crowley, Harry William Charles Cox, and Clarence Frank Leighton, 2, Clement's-inn, Strand, London.

2808. **Improvements in electric cables.** William Phillips Thompson, 31, High Holborn, London. (Franz Clouth, Germany.)

2816. **Improvements in secondary batteries.** Frank King, 47, Lincoln's-inn-fields, London.

2817. **Improvements in or connected with electrical conductors for heating purposes.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

2827. **Improvements in primary batteries.** Charles Lucien Charlopin, Vincent Marie Cornély, and Louis Charles Henry Dautelf, 70, Palace-chambers, Westminster.

FEBRUARY 9.

2874. **Improvements in or connected with electric lamps for surgical operations.** William Henry Buckley, 57, Barton-arcade, Manchester.

2883. **A new or improved process to render the liquid of primary or secondary batteries motionless.** Auguste Lesquoy, 70, Palace-chambers, Westminster.

2894. **Improvements in the production of zinc chloride and in the generation of electricity.** Richard William Hill, 97, Newgate street, London.

2913. **Improvements in series parallel controllers.** James Devonshire, 24, Southampton-buildings, Chancery-lane, London. (Edward D. Priest, United States.) (Complete specification.)

2914. **Improvements in systems of electrical distribution.** James Devonshire, 24, Southampton-buildings, Chancery-lane, London. (Charles P. Steinmetz, United States.) (Complete specification.)

2915. **Improvements in systems of distribution by alternating currents.** James Devonshire, 24, Southampton-buildings, Chancery-lane, London. (Charles P. Steinmetz, United States.) (Complete specification.)

2916. **Improvements in systems of electric distribution.** James Devonshire, 24, Southampton-buildings, Chancery-lane, London. (Charles P. Steinmetz, United States.) (Complete specification.)

2917. **Improvements in systems of electrical distribution.** James Devonshire, 24, Southampton-buildings, Chancery-lane, London. (Charles P. Steinmetz, United States.) (Complete specification.)

2918. **Improvements in windings for dynamo-electric machines.** James Devonshire, 24, Southampton-buildings, Chancery-lane, London. (Charles P. Steinmetz, United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1894.

3109. **Electric locomotive.** Imray. (Rinecker.)

3294. **Electric lighting apparatus for gas-burners.** Peterson.

4366. **Dynamo-electric machines.** Boult. (Compagnie de l'Industrie Electrique)

5314. **Magnetic separators.** Anderson.

5721. **Electrolytic decomposition of common salt.** Smith. (Jorgensen.)

18217. **Transmitting telephonic messages between shore and lighthouse, etc.** Blake.

21353. **Electric, etc., motors for railway vehicles.** Park.

21629. **Electric railways.** Hanisch and others.

24234. **Electric lighting reflectors.** Körber.

24374. **Insulation of electric wires or cables.** Clouth.

24431. **Telegraph, etc., posts.** Siemens Bros. and Co. and Perry.

24630. **Dissociating soluble salts by electrolysis.** Blackmore.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅛-5⅜
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅞-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2⅞-2⅞
—— 4½ Debenture Stock	100	115-118
Charing Cross and Strand	5	5-5⅛
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13½-14½
—— 6 per cent. Cumulative Pref.	10	15½-15¾
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	48-50
—— 4 per cent. Debenture Stock	100	128-130
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	3-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	102-107
Electric Construction, Limited	2	½-½
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1½-1⅝
Elmore's French Company	2	1/16-3/16
Elmore's Wire Company	2	1-1⅛
Fowler-Waring Cables	5	½-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	9½-10½
—— Preference	—	12
House-to-House Company, Ordinary	5	2½-2⅝
—— 7 per cent. Preference	5	6¼-7
India Rubber and Gutta Percha Works	10	23¼-23½
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge	5	7-7⅛
—— 6 per cent. Pref.	—	7-7⅛
Liverpool Electric Supply, Ordinary	5	7 5/16-7 7/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8¼-8⅜
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	½-⅝
Metropolitan Electric Supply	10	9⅜-10½
—— 5 per cent. Reg. Debentures, 1-10,000 in Bonds of £10, £20, and £40	—	—
National Telephone, Ordinary	5	5⅜-5⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	6-6¼
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7-7⅛
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	—	7-7⅛
—— £4½ shares	—	5⅜-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅜-8⅛
—— 7 per cent. Pref.	5	8⅜-9⅛
Swan United	—	—
Telegraph Construction and Maintenance	12	42-44
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7⅛-8
Yorkshire House-to-House	5	5⅛-5⅜

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NOTES.

New Calendar.—Messrs. Ernest Scott and Mountain, Limited, have sent us a calendar for 1895.

Northern Society of Electrical Engineers.—The council have elected Mr. S. Z. de Ferranti a vice-president of the society in place of the late Mr. G. E. Preece.

Electric Bells.—The division electric bells failed to act in the House of Commons one day last week. Such was, however, not the case at Drury-lane pantomime.

Paris Exhibition.—The *Revue Industrielle* suggests the construction of electric tramways in Paris for the transport of visitors to and from the exhibition to be held in that city in 1900.

New Rectifier.—It is announced that Messrs. Ganz and Co., of Budapest, will shortly introduce a new rectifier having the property of transforming an alternating current into a constant continuous current.

Electric Tanning.—We have received a copy of a paper read last month by Mr. L. A. Groth before the Society of German Leather Manufacturers descriptive of his system of tanning by electricity.

Society of Arts.—On Wednesday next, at 8 p.m., a paper on "Furnaces for Roasting Gold-Bearing Ores," by Mr. C. G. Warnford Lock, will be presented. Prof. W. C. Roberts-Austen, C.B., F.R.S., will preside.

Steam Tramways in Italy.—The Institution of Civil Engineers have just issued an illustrated paper on "Steam Tramways in Italy," by Mr. P. Amoretti, manager of the Steam Tramway Association, Turin.

Building Trades' Exhibition.—A proposal is under the consideration of the Consultative Council of this exhibition for the purposes of having lectures delivered at the exhibition on electricity in building operations.

Electricity on Warships.—The "Barfleur," which has been selected to replace the "Sans Pareil" in the Mediterranean, has been fitted with electric gear for working her guns, which has given the utmost satisfaction.

Municipalisation of Tramways.—The London County Council Tramways Bill was read a second time in the House of Commons on Tuesday. A Bill to facilitate the working of tramways by local authorities has been issued.

Medals for Bravery.—The London County Council on Tuesday awarded their silver medal for extraordinary bravery to Firemen F. Bishop and W. J. Tizard in connection with the recent fire at Kensington Court electric light station.

Waterloo and City Railway.—The City Commission of Sewers on Tuesday approved a plan and section of the proposed works of the Waterloo and City Railway from Blackfriars Bridge (underneath Queen Victoria-street) to Queen-street.

Red Sea Cable.—The French Chamber of Deputies have adopted the credit of 1,800,000f., or, say, £72,000, for the laying of a cable between the French Red Sea port Obock and Djibouti, the southernmost point of the French territory on that coast.

The Ferranti Effect.—This phenomenon was discussed by Mr. Carl Pichelmayer before a recent meeting of the Vienna Electrotechnical Society. The paper, which is treated mathematically, is published in the *Zeitschrift für Elektrotechnik* of February 15.

Rating of Machinery.—The second reading of the Rating of Machinery Bill was moved on Wednesday in the House of Commons by Sir W. Houldsworth. It was carried by a majority of 51. The Bill was referred to a Grand Committee by a majority of 36.

The Kensington Fire.—A verdict of death from suffocation was returned in the case of the child who met her death in connection with the fire at Kensington Court station last week. The jury stated that there was not sufficient evidence to show how the fire originated.

Having a Drop.—It appears from figures published that the consumption of coal gas in Paris during 1894 diminished by approximately 3,000,000 cubic metres as compared with the previous year. No doubt the increase in the use of the electric light has contributed to this result.

The Day Load.—In referring to a paper read recently before the Société Internationale des Electriciens on the Hermite system of sanitation, a French contemporary suggests that the method should prove of great benefit to supply companies in the direction of providing them with a day load.

Price-List.—Mr. Severin Senator, 128, Wilhelmstrasse, Berlin, S.W., sends us price-lists of incandescent lamps, arc lamps, and carbons. He also informs us that his business comprises all branches of electrical applications, especially electric light installations, and all material and accessories for the same.

Cable Communication with Lightships.—The General Purposes Committee of the Canterbury Corporation have decided to send a letter to the Board of Trade asking them to accelerate as far as possible the establishment and extension of electric cables between the lightships and the shore.

Hawaiian Cable.—A Reuter's telegram from Washington, dated 19th inst., says that the conferees of the Senate and the House of Representatives are unable to agree as to the item of 5,000,000dols. for beginning the laying down of the Hawaiian cable, and that a further conference has been ordered.

Institution of Electrical Engineers.—The discussion will be resumed on Thursday next of the paper presented last week by Mr. W. B. Sayers, associate, on "Reversible Regenerative Armatures and Short-Air-Space Dynamos." The paper and discussion thereon at the meeting on the 14th ult. were given in our last issue.

Telephony in Russia.—It is stated that the Russian Government have granted concessions for 20 years for the establishment and working of telephone exchanges in 11 towns. The Government will receive 10 per cent. of the net receipts, and the telephone systems will become the property of the State at the expiration of the 20 years.

Regulations for Installations.—A few weeks ago we published a translation of the fire insurance regulations drawn up by the Technical Committee of the Berlin Electrotechnical Society. These regulations were discussed at a meeting of the society on 22nd January, when various proposals were made for alterations in the projected rules.

Electric Railways in London.—The Parliamentary Committee of the London County Council on Tuesday recommended that a petition be sealed and presented, if necessary, against the London, Walthamstow, and Epping Forest Railway Bill, but that no action be taken with regard to the City and South London Railway Bill and the Great Northern and City Railway Bill.

Institution of Civil Engineers.—The discussion will be resumed on Tuesday next of the paper by Messrs. Butters and Smart, on "Plant for the Extraction of Gold by the Cyanide Process"; and, time permitting, papers will be read on "Electric Haulage at Earnock Colliery," by

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Mr. Robert Robertson, B.Sc., M.I.C.E.; and on "Electricity Applied to River Gold-Dredging," by Mr. Robert Hay, M.I.C.E.

Gas-Engine Competition.—It appears that the projected competition of gas-engines, to which we referred a few weeks ago, and which was promoted by the Société Technique de l'Industrie du Gaz, has completely collapsed. A circular to this effect has been issued by the society, who state that this decision has been arrived at in consequence of there being only six entries, including the Niel, Crossley, and Charon gas-engines.

Cable Rates to South Africa.—A telegram from Pretoria states that the negotiations between representatives of the South African States and the cable companies for the reduction of the cable rates between England and South Africa have reached an important stage, the Transvaal Government having agreed to pay an annual subsidy of £10,000 for 15 years provided the tariff be reduced from 8s. 11d. to 5s. per word.

Telegraphic Arrangements. — The Newcastle Chamber of Commerce on Wednesday decided to recommend the National Association of Chambers, meeting in London next month, to urge upon the Government the necessity of immediately placing telegraphic intercommunication between commercial and seaport towns in such a position as to render interruption by storms no longer possible.

Royal Institution.—The Right Hon. Lord Rayleigh, F.R.S., professor of natural philosophy in the Royal Institution, will deliver a course of six experimental lectures on "Waves and Vibrations," at the Royal Institution, on Saturdays, March 2, 9, 16, 23, and 30, and April 6. His lordship will also deliver the Friday evening discourse on April 5, when his subject will be, "Argon, the New Constituent of the Atmosphere."

Gas-Engines for Electric Lighting.—A communication was read by M. V. Langlois before a recent meeting of the Société des Ingénieurs Civils de France dealing with the industrial application of gas-engines, particularly for electric lighting. The author showed that it is more advantageous to use a gas-engine to drive a dynamo for the production of light than it is to utilise the coal gas direct for illuminating purposes.

Institution of Junior Engineers.—To-morrow (Saturday) the members of this society will visit the works of Messrs. Siemens Bros. and Co., at Woolwich, where they will be received by the president, Mr. Alex. Siemens. The train conveying the visitors will leave Charing Cross at 9.20 a.m. On Friday next, March 1, a paper by Mr. A. H. Newsam Smith, on "Locomotive Repairing Works," will be read at a meeting to be held at the Westminster Palace Hotel.

Personal.—The St. Pancras Vestry have appointed Mr. Thos. Cooper, M.A., late of Oxford, assistant engineer at the Regent's Park electric light station.—Mr. George Duffitt, who was for many years connected with the Edison and Swan Company, has been appointed by Froggatt's Electric Lighting Company, Limited, to proceed to Glasgow to take charge of the lighting of the Corporation tramcars, and to fit up a charging station at Coplawhill.

American Report on Units and Standards.—The January issue of the *Transactions* of the American Institute of Electrical Engineers contains the report of the Committee on Units and Standards, together with a printed copy of an Act—passed in July last—defining and establishing units of electrical measurement in the United States. The report is practically identical with that published in our issue of August 24, 1894, page 222, to which we refer our readers.

Card of Electrical Engineering Plant.—An attractive speciality card has been brought out by Messrs. Ernest Scott and Mountain, Limited, Newcastle-upon-Tyne. One page illustrates a variety of steam-engines, pumps, and fans; the second shows machinery for the electrical transmission of power; and the third represents plant for electric lighting. In fact, the card shows in brief a number of the company's manufactures, besides containing a calendar for 1895.

New York "Electrical Review."—No, no, dear *Electrical Review*, you have been wool-gathering, and no wonder can therefore be expressed at your missing the point. We always leave to our contemporaries the pleasant duty of padding out their columns with what is of no earthly interest, confining our remarks to briefly stating the facts of any particular case. So, of course, we left the lack-of-interest Brooklyn strike to them—and to you. Do you feel better now?

The Proposed Pacific Cable.—An Ottawa cablegram, dated February 15, says that the Minister of Trade states that the lowest tender for laying the Pacific cable has been received from a London firm, the amount being £1,517,000. The route proposed is from Vancouver to Fanning Island, Fiji, and Norfolk Island, the cable dividing at the last-named place into branches to New Zealand and Australia. The amount of the tender is about half the estimate made by the British postal authorities.

New Method of Cable Jointing.—A reliable method of jointing one end of a cable to another or to an end contact (cable shoe) is described by Mr. K. Feussner, of the Physikalische Technische Reichsanstalt, Charlottenburg, in the *Electrotechnische Zeitschrift* of January 31. The system consists in stripping the insulation off the cable end and placing over the latter a thin copper collar, so that the whole can be mechanically compressed together. The newly filed cross-section of the cable can then be easily soldered.

Electrometallurgical Work in France.—Several proposals were brought before a recent meeting of the Société Electrométallurgique Française of Froges and were adopted. One was to amalgamate the company with the Société Française de l'Alumine Pure, so as to place the company in a better position to obtain aluminium; the second was to allow the Neuhausen Aluminium Works to become large shareholders in the company; and the third was to increase the capital of the company by £128,000.

Mechanical Traction.—It was mentioned by Mr. E. M. Underdown, Q.C., at a meeting on Tuesday of the Tramways Union Company, who have lines in Bremen, Bucharest, and Madrid, that there was no doubt that animal traction was a very expensive method, and that the question was whether they could have any reasonable chance of success by substituting mechanical traction. He stated that we seemed to be within measurable distance of applying electric traction to tramways, and when that time arrived the company were ready to assist in the cost of substitution.

Telephony for Cavalry.—A course of instruction in telegraphy for the Austro-Hungarian cavalry has been approved by the Emperor. The object is to train commissioned and non-commissioned officers of that arm of the service for the despatch of communications by telegraph and telephone. The technical part of the course will be under the control of the chief of the Telegraph Department, who will be assisted by a cavalry officer and

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three non-commissioned officers, as well as by a couple of men from the Railway and Telegraph Corps and a number of subordinate teachers.

Prevention of Gas Explosions.—Mr. W. Harpur, the borough engineer of Cardiff, writes that no trouble has been experienced in regard to the accumulation of gas in connection with the underground electric light mains, and that none is anticipated. The transformer-chambers are ventilated by running a ventilating-pipe up the side of the nearest building, and, to the best of his knowledge, this method is satisfactory. It is an open question amongst engineers as to the most practical method of preventing explosions. The culverts are drained by being provided with open bottoms to the connecting and drawing-in boxes.

Electric Traction in Italy.—A scheme has been presented to the Italian Minister of Public Works with a view to the granting of a concession to Mr. L. Besozzi, of Milan, for the construction of an electric tramway from Gravellona to Intra. The duration of the concession is suggested at 90 years, and a subsidy of £120 per kilometre of line is requested for 70 years. The total length of the projected line is nearly eight miles, and the estimated cost of construction and equipment is £60,000. According to a Berlin paper, Messrs. Schuckert and Co., of Nuremburg, are acquiring an interest in the Turin Horse Tramway Company with a view to introducing electric traction on the line.

New Central Station in Paris.—It appears from *L'Energie Electrique* that the new board of management which has been elected for the Compagnie Parisienne d'Air Comprimé has commenced the erection of a new central station on the Quai Jemmapes. The site, which is on the canal bank, will allow of the accommodation of plant to the extent of 20,000 h.p. At the present time three units of 75 kilowatts are being installed. Each set comprises a Corliss vertical engine, coupled direct to a dynamo made by the Société Alsacienne de Constructions Mecaniques. The engine-room is on the ground floor, and the boiler-house on the first floor. The boilers are of the Belleville type, four of which will be provided for each unit. The method of distribution will remain on the five-wire system as hitherto.

Synchronous Alternating-Current Motors.—The subject of transmitting energy by means of synchronous alternating-current machines was discussed by M. R. V. Picou before a recent meeting of the Société Internationale des Electriciens. The author, who stated that no special treatise existed on the application of alternating-current motors, said that in England Mr. Mordey had published the result of some investigations dealing with synchronous motors, as had also Prof. Silvanus Thompson and Mr. G. Kapp. In France, M. Blondel had issued a pamphlet on the coupling of alternators, but the author stated that it was not so simple as the method he exhibited. M. Picou then demonstrated that synchronous machines, when the excitation was once well regulated, ought to ensure the current at all loads.

Government Telegraph Works.—The Postmaster-General, accompanied by Mr. Walpole and Mr. Lamb, visited the telegraph factories at Holloway and Mount Pleasant on Saturday morning, and announced that the hours of work would be reduced to eight a day on and from March 1. He explained in general terms the conditions under which the change would be effected, and expressed his conviction that the workmen would do their utmost to make the experiment a success. The announcement was well received at both factories, and hearty cheers were given when the Postmaster-General concluded his remarks. Mr. Walpole added a few words, to assure the men that the concession which the Postmaster-General had announced on behalf of the Government was warmly supported by the responsible permanent officials, who expected that the result would be such as to afford a complete justification of the policy of the Government.

Copper Wires for Plain Leads and Cables.—The well-known firm of Messrs. Lazare Weiller and Co., who have electrolytic smelting works at Angoulême, have just issued, through their British representative (Mr. Fernand Espir, of 3, East India-avenue, London, E.C.) a pamphlet dealing with the uses of the electrical conductors made by them. The pure high-conductivity copper made by the company is produced in rods and bars for wire-rolling, and in rolled rods for wire-drawing and also for dynamos. Apart from this, the company manufacture plain leads for telephone wires, electric lighting, and the transmission of power, the conductors being made to suit any requirements in the directions of wires of all sizes, in plain cables of different sections, and in plain strips, trolley wires, etc. The pamphlet gives a lot of useful information concerning the diameters, areas, weights, and resistances of copper and silicious bronze wires and cables, and various conversion tables.

Utilisation of the Nile.—A paper was read recently before the Egyptian Institute in Cairo by Mr. Prompt, inspector-general of the roads and bridges, dealing with the utilisation of the water power of the cataracts for improving the condition of agriculture in the country. Reassured by the Lauffen-Frankfort experiments, the author suggested the establishment on the Nile near Assouan of an artificial fall of 15 metres, which, on the one hand, would allow of the storage of 500 million cubic metres of water, and, on the other, would yield 40,000 h.p. A second dam would be provided near Cairo. Mr. Prompt estimated that motive power could be supplied cheaply, that the cost of the works would amount to £1,600,000, and that the net revenue would reach 40 per cent. on the capital expended. In conclusion, the author laid stress upon the practical results which would follow the carrying out of the project, as, for instance, the irrigation of land where corn and sugar canes are grown, and the increase in the price of cotton by the use in the country of half of the total production.

Royal Meteorological Society. — The monthly meeting was held on Wednesday, Mr. R. Inwards, F.R.A.S., president, in the chair. Mr. W. Marriott gave an account of the thunderstorm and squall which burst over London so suddenly on the morning of January 23. It appears that this storm passed across England in a south-easterly direction at the rate of about 47 miles an hour—being over Northumberland at 4 a.m., and reaching the English Channel by 11 a.m. Thunder was first heard in the vicinity of Leeds, and accompanied the storm in its progress across the country. One of the most remarkable features of the storm was the sudden increase in the force of the wind, for in London it rose almost at one bound from nearly a calm to a velocity of 36 miles an hour. This sudden increase of wind caused considerable damage, and at Bramley, near Guildford, 28 trees were blown down along a track 1,860 yards in length. Mr. E. Mawley presented his report on the phenological observations for 1894, and Mr. A. B. MacDowall read a paper on some gradual weather changes in certain months at Greenwich and Geneva.

Electro-Harmonic Society.—As mentioned in our last issue, a ladies' night of this society will be held this (Friday) evening in the Banquet-room at the St. James's

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Hall Restaurant, Regent-street, W. The following is the programme—Part I.: instrumental selection; song, "Sleep and Remember, Beloved" (Tosti), Mr. Arthur Thompson; song, Miss Florence Bethell; pianoforte solo, Mr. Alfred E. Izard; songs (*a*) "Les Perles d'Or" (F. Thomé), (*b*) "The Daily Question" (Meyer-Helmund), Miss Mary Hay; vocal scena, "Maya" (Roeckel), Mr. T. H. Harrison; string quartette (Schubert), MM. Gatehouse, Greebe, Chaunell, and Belinski. Part II.: vocal duet, "Oh! that we Two were Maying" (Gounod), (by desire), Miss Florence Bethell and Miss Mary Hay; Arabian love song, "Medjé" (Gounod) Mr. Arthur Thompson; violin solo, "Nocturne in E flat" (Chopin-Sarasate), Mr. T. E. Gatehouse; song, Miss Florence Bethell; song, "In Passionate Surrender" (Fredk. Rosse), Mr. T. H. Harrison; 'cello solo, (*a*) "Andante," (*b*) "Mazurka" (Popper), Mr. Mirko Belinski; new song, "In Years to Come" (Madge Conroy), (accompanied by the composer), Miss Mary Hay; instrumental selection, "Loin du Bal" (Gillet).

Oxford Meeting of the British Association.—The official report of the Oxford meeting of the British Association has been issued. The volume contains the opening address of the Marquis of Salisbury and the addresses of the nine presidents of sections. Abstracts are given of many of the papers read, and some are mentioned by title only. On the other hand, there are papers that were ordered by the General Committee to be printed *in extenso*. The latter include those on a lecture-room experiment to illustrate Fresnel's diffraction theory and Babinet's principle, by Prof. A. Cornu; the connection between chemical combination and the discharge of electricity through gases, by Prof. J. J. Thomson, professor of Experimental Physics, Cambridge; on the electrification of molecules and chemical change, by Mr. H. Brereton Baker; and a report on planimeters, by Prof. O. Henrici. The reports presented by previously appointed committees and investigators include the following: reports on the state of our knowledge of thermodynamics, by Mr. G. H. Bryan and Prof. Ludwig Boltzmann; report on experiments for improving the construction of practical standards for electrical measurements; and the report received by the Mechanical Science Section on methods of determining the dryness of steam.

Central Stations in France.—With reference to our note on this subject in our issue of 8th inst., the following are some of the details of the statistics of central electric light stations in France on January 1 last: There were at work, excluding Paris, 328 stations, against 301 on January 1, 1894, or an increase of 9 per cent. The total power amounts to 40,000 h.p., divided as follows: 151 stations use water power to the extent of 9,650 h.p. (24·5 per cent.); 39 stations water and steam power, 6,000 h.p. (15 per cent.); 119 stations steam power, 22,000 h.p. (56 per cent.); five stations poor gas, 220 h.p. (·55 per cent.); and 14 stations town gas, 1,550 h.p. (3·95 per cent.). With respect to the nature of the systems, there are 260 stations, of a total of 27,895 h.p. (70·75 per cent.), using continuous current; 73 stations, with 10,645 h.p. (27 per cent.), using single alternating current; and three stations, with 880 h.p. (2·25 per cent.), using polyphase currents. These statistics show the development of alternating stations, the average power of which is largely above that of the continuous-current stations. The average horse-power of the former is 145 h.p., and of the latter 110 h.p. Of these stations, 29 are run by municipalities. These are all small concerns utilising water power obtained cheaply from neighbouring streams. There are 26 stations, some important, exploited by gas companies. On January 1 there were 34 stations being built, and 74 were more or less advanced in project form—a total of 108 as compared with 115 at the same period last year.

The Projected Elevated Railway in Berlin.—It would appear from a report published by a Berlin newspaper that the long-projected elevated electric railway for Berlin is assuming a definite shape; but as this rumour has so frequently been spread about, it is well not to place too much reliance upon it at the moment. At the same time it may be mentioned, on the authority of that paper, that the negotiations entered into by Messrs. Siemens and Halske, the promoters of the enterprise, have been brought to a conclusion. The agreement between this firm and the municipal authorities has been drawn up and is on the point of being signed, and the negotiations for the crossing over of several existing railway lines have been concluded. The continuation of the line from the Nollendorfplatz through the Charlottenburg district to the Zoological Gardens has been satisfactorily arranged, so that the agreement between the firm and the town of Charlottenburg can now be determined. As the line from the Warsaw Bridge to the Nollendorfplatz with two branches to the Potsdam place was sanctioned by ministerial order in 1893, the imparting of the concession is now only a matter of form to be fulfilled. According to the present scheme, the elevated electric railway will commence at the Warsaw Bridge, near the Berlin Metropolitan Railway, and will terminate at the Nollendorfplatz; whilst the proposed extension of the line will be continued to the Zoological Gardens.

Municipalisation of Telephony.—Mr. Foster has asked the Chancellor of the Exchequer whether, in view of the dissatisfaction which existed in various municipal bodies, both in England and Scotland, respecting the terms of the proposed contract between the Postmaster-General and the telephone companies, and the desire expressed in the House that the matter should be properly discussed in the House before the agreement was signed, the Government would afford facilities for that purpose before the signature of the agreement. The Chancellor of the Exchequer said negotiations were already in progress which he hoped would result in favourable terms being arrived at. Captain Bagot asked the Postmaster-General in the House of Commons on Friday whether he would place upon the table of the House returns showing the earnings of the different telephone trunk wires for the past three years which he proposed to buy from the telephone companies, the price he intended to pay for them, and copies of the reports of the Post Office experts on their condition and value. Mr. Benn also asked whether the signing of the agreement could not be postponed until the question of the municipalities obtaining licenses was discussed in the House. Mr. A. Morley said that the valuation of the trunk wires of the telephone companies, which is now being proceeded with, would take some time to complete. He was therefore not in a position to furnish the information on this point. He had no accurate information with respect to the earnings of those wires. Mr. H. S. Foster asked whether the House would have an opportunity of discussing the question before the agreement was signed. Mr. A. Morley said that members interested in the question would have an opportunity of balloting for a day to bring it forward. Mr. J. W. Benn has given notice that on March 1 he will call attention to the proposed agreement between the Post Office and the National Telephone Company, and move a resolution.

Electric Motors in a Sugar Factory.—Dr. O. Köhler, in the *Deutsche Zuckerindustrie*, gives an account of an electric installation in the Groningen sugar factory. The chief plant, about half-a-mile distant from the works,

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consists of two Siemens and Halske dynamos of 41,600 watts and 23,000 watts respectively, these being driven by turbines. In the factory there are, in addition to a 120-cell battery of accumulators of 594 ampere-hours, two independent steam-engines connected with two Siemens and Halske dynamos as a reserve. The dynamos supply current for 750 incandescent lamps and 10 arc lamps, as well as for five small electric motors and two large electric motors. The small motors have taken the place of steam-engines and long shafting, and have worked faultlessly for two years, and even the commutators are uninjured, as carbon brushes have been used. The economy in the employment of the motors has been specially noticeable in the case of a lift, which was formerly driven by a 3-h.p. steam-engine. The figures show that only half the amount of power is now expended. Often during the sugar campaign power is required in exceptional positions, when the conductors can be quickly run and attached to a portable motor which supplies the required power, which otherwise could only have been obtained with much difficulty and at great expense. For sugarworks, with their intermittent working and having a varying amount of product in different seasons, such a system possesses very special advantages, and Dr. Köhler is of opinion that soon electric motors will drive small steam-engines out of sugarworks, and so allow of a centralisation of the steam power. They will also obviate the use of lengthy shafting, and thus obviate waste of power. Electric motors are also specially adapted for driving centrifugal machines, when each centrifugal can be driven independently.

Electric Lighting in Germany.—Old rolling mills which were established at the beginning of the century at Dahlhausen-on-the-Ruhr, and which are now in a half-ruinous condition, are to be converted into a central electric light station. Water power is available.—An extension has taken place of the electric light installation at the central railway station, Munich, the latest portion being the lighting of the section from the engine-house to the Ullmann Bridge. The high-tension conductors are provided with catching-nets, so that in the event of a breakage the conductor would not cross other wires.—The Rendsburg Municipality propose to establish a central electricity station, and a committee has been appointed to visit other towns where central stations exist.—At Tübingen a scheme is on foot for utilising the power of the Neckar for the generation of current for lighting and power purposes.—A central station has been completed at Horb, the work having been carried out by Mr. W. Reisser, of Stuttgart. There are at present 600 lamps connected, but the local authorities having seen the excellent results obtained, have now determined to light the streets and all the public buildings electrically. The pumps of the high-pressure water supply are also to be worked by electric motors instead of by steam-engines.—The mains of the Berlin electricity works are to be extended in the western, south-western, and eastern parts of the city, and the plant will be increased by two steam dynamos of 2,000 h.p. respectively. It is intended to increase the capital of the company to £180,000.—A central station, to be erected at Gelsenkirchen by Messrs. Siemens and Halske, will supply current not only for general lighting and power purposes, but also for electric tramway lines.—The large oilworks of Messrs. von Schayck at Strälen have had the electric light installed, there being 75 incandescent lamps and four arc lamps.—The local authorities of Augsburg have invited Messrs. Schuckert and Co. of Nuremburg, and Messrs. Siemens and Halske, of Berlin, to draw up plans for the erection of a central electric light station.—By arrangement between the Bavarian Vereinsbank, the Allgemeine Elektricitäts-Gesellschaft, and Mr. Oscar von Miller, a central station is to be provided for Schwandorf. This will be the first town in the Upper Palatinate to be lighted electrically throughout.

Spectrum of the Electric Discharge.—Messrs. G. D. Liveing and J. Dewar in the *Philosophical Magazine*, dealing with the question of the spectrum of the electric discharge in liquid oxygen, air, and nitrogen, state that these, like non-electrolysable compound liquids, offer great resistance to the passage of an electric discharge, so that the spark could only be made to pass through a thickness of 1mm. of liquid. When the thickness was less than this, a succession of sparks could be maintained; but the resistance appeared to be very great, and the disruptive effect on the platinum electrodes was sufficient to discolour the liquid by the particles thrown off their surfaces. The discharge through the liquid in all cases gave a continuous spectrum and some bright lines traceable to the electrodes, whilst the rays supposed to have been emitted by the molecules of the liquid were less conspicuous. It seems not unlikely, therefore, that the continuous spectrum was due to the particles thrown off the electrodes. With liquid oxygen boiling at atmospheric pressure, and both electrodes being immersed in the liquid at a distance of 1mm. or less, a continuous spectrum is obtained, brightest in the yellowish-green, but extending to some distance both on the red and on the blue side. The absorption bands of oxygen were conspicuous on this bright background. With a Leyden jar in circuit, the brilliance of the spectrum is increased and some additional lines brought out. Many more bright lines were produced by keeping only the lower electrode immersed in the liquid, so that the spark passes partly through the liquid and partly through the gas immediately above it. Most of these correspond with known lines of oxygen. Exhaustion of the gas above the liquid, until the pressure was reduced to about 10mm. of mercury, did not make any marked difference in the appearance of the spectrum so long as both electrodes were immersed in the liquid. But when the lower electrode only was immersed and a Leyden jar put in circuit, a good many bright lines came out. The passage of the discharge through the liquid produced much ozone. Not only was the smell of ozone very strong, but the liquid took the indigo tint, deeper than the blue of ordinary oxygen, which is characteristic of ozone. The effects of the discharge through liquid air were very similar to those produced with liquid oxygen, as long as the pressure was that of the atmosphere, and no jar was in circuit. When a jar was used a much larger number of lines, generally resembling the ordinary air lines, was seen but not measured. When the pressure was reduced, the usual banded spectrum of nitrogen was seen, and was strong relatively to the spectrum of oxygen. As the liquid evaporated, and thereby lost more nitrogen than oxygen, the two green bands due to oxygen appeared to become stronger actually, as well as relatively to the nitrogen bands. In this case, the discharge produced oxides of nitrogen, which were detected in the residual gas when the air had all evaporated. With liquid nitrogen at atmospheric pressure, both electrodes immersed, a faint very diffuse line was observed at about $\lambda 501$. This became more distinct when only one electrode was immersed, and probably represents the strong double line of nitrogen in that position. With the jar in circuit the spectrum was a series of bright lines similar to those given by gaseous nitrogen at atmospheric pressure. Under reduced pressure, one or both electrodes being immersed, and no jar used, the band spectrum of nitrogen appeared. On putting on the jar, this was replaced mainly by the line spectrum.

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ELECTRIC MOTORS FOR OPERATING MACHINE TOOLS AND OTHER APPLIANCES.

The question of satisfactorily employing electric motors for workshop and factory purposes does not fortunately depend upon the classical utterances of learned professors in their respective lecture theatres, nor yet upon the prejudices of engineers who consider that old-time methods are the best for modern requirements. The greatest proof of economical development in working, and of real success in this direction, is given rather by the frequency with which the erection and equipment of electric motive-power transmission plants are chronicled in the technical papers: and object lessons, such as those of the Royal Belgian Small-Arms Factory at Herstal, or the almost equally important private installations at the works in this country of Messrs. Siemens Bros., W. T. Henley's, or the Electric Construction Company, do far more good in showing the advantages of electric motors for power purposes than any amount of talk or criticism.

There is, however, some considerable degree of useful service accomplished by recording what has been done

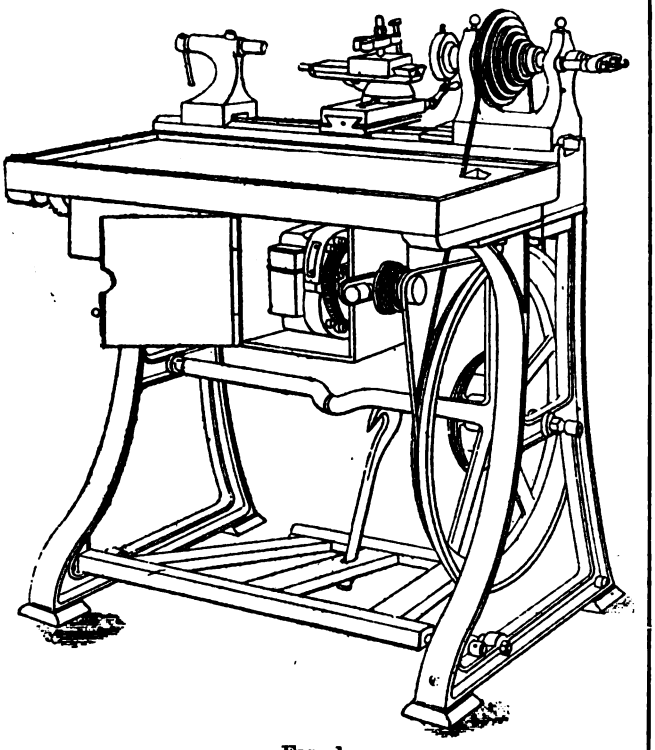

FIG. 1.

with regard to the installation of electric motors: and hence we abstract a few particulars respecting some points of interest in workshop practice from a very long exhaustive report prepared by Messrs. G. Dumont, G. Baignères, and A. Lencauchez upon the subject of electric energy transmission in general, and recently submitted by them to the Société des Ingénieurs Civils of France.

The two instances of power transmission which we have selected to place before our readers are shown in the annexed illustrations. The first of these illustrates a small foot lathe for brass or wood work. The motor, as will be seen, occupies a small box fixed underneath the bed of the lathe, and has a projecting spindle upon which is mounted a small grooved speed cone. A band from this may be connected either to the flywheel on the crankshaft or to the lathe head cone itself, thus giving a considerable range of speed. The treadle may, if desired, be kept in order to help in stopping the motion, the workman using it as a brake.

The second illustration shows the general plan or scheme of an overhead travelling crane, in which a separate motor is employed for each distinct operation, whether longitudinal or cross traverse, lift or slew. Usually these different operations are carried out by a single motor of large size, with friction-clutch devices for throwing in the spindles and gear designed for each movement. The adoption of separate motors does not, however, preclude their proper management or operation from one single point, whilst it does secure the positive advantage of greater variations in speed.

In the method illustrated four motors are used; these are all shunt wound, and run in either direction as desired. Four switch levers, connected to the machines, are mounted on a switchboard, which also carries the omnibus bars from the generator, the safety cut-outs, measuring instruments, etc. Five circuits are joined up to the bus bars; four of these pass to the motor armatures, and the fifth is the common exciting circuit used for the motor fields. Ammeters are mounted at a_1, a_2, a_3, a_4 for each circuit; V is a voltmeter, thrown in or out by a button switch, i; A is a large ammeter on the main generator circuit; I is a multiple switch whose contacts are so arranged that the current from the generator passes first through the motor fields—the armatures are then switched in by moving the switch handle further round; F is a main cut-out; f^s a smaller one in the exciting circuit;

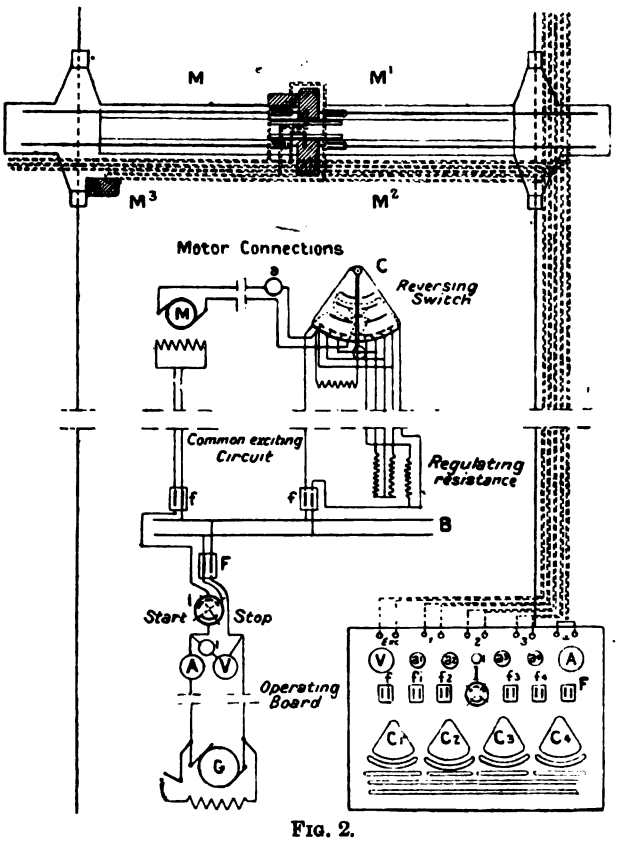

FIG. 2.

f_1, f_2, f_3, and f_4 are similar fuses in the motor armature circuits, C_1, C_2, C_3, C_4, shown at the base of the operating board, are the manual lever switches used for each motor—*i.e.*, each desired operation: traverse lengthways or across, lifting, and swivelling. When the lever of any switch is in a vertical position (as may be seen from the inner diagram, which represents the connections of one motor) the armature of that machine is short-circuited through a resistance of sufficient amount to avoid excess of current; throwing the load off in this way through a powerful resistance acts as a brake, and gives considerable ease of manipulation.

By turning the lever to right or left, the armature is switched in through a regulating resistance, which is either partly or wholly switched out as the handle moves along the contacts to its extreme points on the right or left. Three different speeds may thus be obtained whether running backwards or forwards, the limits being:

	Empty.		Full load.
Cross traverse.....	150ft. per min.	...	75ft. per min.
Longitudinal traverse	75ft. ,,	...	36ft. ,,
Lift	13ft. ,,	...	5ft. ,,

for weights of from 15 to 30 tons. The regulating resistance may, of course, be calculated so as to give any

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desirable ratio of speed at the different positions of the switch lever.

M, M^1, M^2, M^3 represent the four motors respectively of 6, 10, 10, and 6 h.p. The method of operation is very simple, and does not need elaborating here. A somewhat novel point is the use of the multiple switch, I, which offers the advantage of maintaining the motor fields when momentary stops are made by cutting out their armatures. Of course, by turning the handle of I further round, the exciting current is also cut off, and the motors thus isolated from the generator.

THE DISABILITIES OF YOUTH.

BY THE PHILOSOPHER.

The very characteristic inaugural address of the new President of the Institution of Electrical Engineers is probably still fresh in the minds of most engineers—at any rate, of most electrical engineers. I do not here propose to deal with the whole of that dissertation, but I would examine carefully one not insignificant portion.

I refer to the "note of warning" that was sounded ostensibly for the special edification and enlightenment (?) of town councillors, who were advised to beware of employing young engineers in the preparation and subsequent execution of their electric lighting schemes. Now, I think that most fair-minded folk will agree that before making a statement of this sort—an announcement that may, and probably will, damage the immediate prospects of more than one career honourably begun—Mr. Crompton should have satisfied himself that there really existed a need for this peculiar gratuitous supplication to British town councillors, a class of persons who, though usually ignorant of electrical matters, are nevertheless, for the most part, men who have no small fund of common sense and shrewd business acumen. But we have it on the authority of Mr. Raworth, a gentleman whose special knowledge of this particular subject probably exceeds Mr. Crompton's, that the young electrical engineers whose services have been requisitioned by provincial corporations have, on the whole, done good work, have given good advice, and have, in a word, so conducted themselves as to do credit to themselves and to the Institution to which most, if not all, of them belong.

Obviously, either Mr. Crompton or Mr. Raworth is right. To the most ordinary and casual observer of human affairs it must be abundantly clear that years alone are no criterion of a man's fitness to advise on important engineering matters. A young man almost necessarily possesses energy; he is in a position, if only he has the inclination, to profit by the experience of others who have gone before him, and he is much more likely to give free and impartial consideration to the various methods for arriving at a required result than is the older man, whose opinions have been formed and crystallised into prejudices. The young engineer knows very well that his work will be subjected to a keen criticism, to a searching examination that will not be directed towards the efforts of the man whose reputation has been made, and it may safely be asserted that this very knowledge will cause him to give an amount of careful thought and attention to his maiden effort that ought, and generally does, bring about a satisfactory consummation to his labours. If then, on general principles, it has been shown that Mr. Crompton's "warning" was unnecessary, unjust, and uncalled for, and if, further, it has been shown by Mr. Raworth that the statements which immediately followed the "warning" were inaccurate—that is to say, that our young engineers have done well, and not badly—then one is naturally inclined to a speculation as to the motives which could have prompted our President's reckless and ungenerous utterance. For my part, I can only arrive at one conclusion. It is a well-known fact that Mr. Crompton is more interested in continuous-current patents and appliances than he is in advancing the claims of alternating-current apparatus. There is, perhaps, no more out-and-out advocate of direct-current methods than Mr. Crompton. It is not surprising to find that those who advocate his opinions are amongst the older consulting engineers—men whose electrical convictions were formed before the alternating current entered into the domain of practical engineering politics. Nor am I in the least astonished to find that the younger generation of consulting and executive electrical engineers are the staunchest advocates of alternating current for town-lighting, because they see in it the only simple and ultimate method of economically serving large and increasing areas. What, then, is the result of the above considerations? Simply that Mr. Crompton is very human, simply that he wishes his company to prosper, simply that he knows this is most likely to happen if town-lighting be carried out in accordance with the views and to the specifications of the "older generation" of electrical engineers. It is sheer affectation to pretend that any of us are not self-interested. But some of us occasionally display a little regard for the material well-being of others. So much we have a right to expect from the President of the Institution of Electrical Engineers.

THE INCANDESCENT LAMP.*

BY MANNING K. EYRE.

(Concluded from page 160.)

Enough has been said to show the absolute necessity of a good vacuum, or at least as perfect as we can make it, so we can at once proceed to the description of the process of exhaustion. Fig. 5 is a rough sketch of one of the aisles in the pump-room. In the sketch, *f*, are two large pipes, the upper one feeding the mercury to the pumps, the lower one carrying it off to the reservoir. The mercury is kept in circulation by means of a rotatory screw pump, keeping the Sprengel pumps fed as long as there is a demand

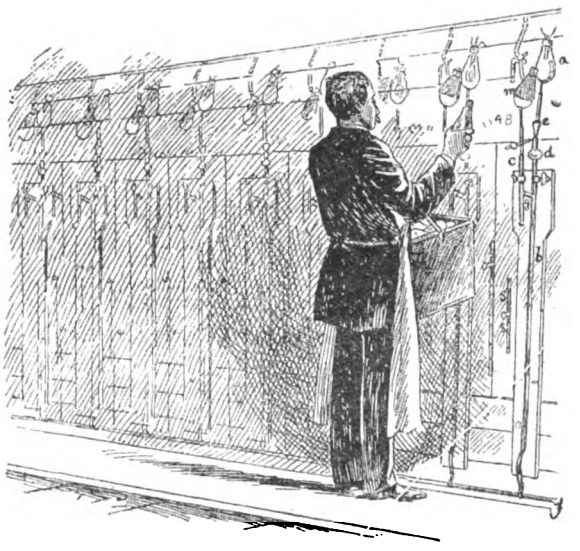

FIG. 5.—Exhausting Lamps.

for the mercury. The lamp, *a*, after leaving the glass-room, is rubbered—that is, a small rubber cap is placed on the end of the small exhaust tube, which, when the lamp is placed on the pump, fits into the cup, *e*, forming an airtight joint. As the process for exhaustion continues, the internal pressure being removed, the external pressure forces the lamp and tube more and more into the cup, *e*, making a tighter joint where a tight joint is most necessary. Below the joint is a small receptacle, *d*, in which is kept a little phosphoric anhydride to absorb any moisture. Below this again is the main tube, *b*, through which the mercury and air fall. This tube must be a few inches longer than an ordinary barometer tube, 30in The action of the pump is very simple. The lamp having been placed on the pump, the mercury carried over in the upper pipe, *f*, falls in a fine stream through the small tube, *c*, and connecting tube, *g*, and at this point forces air down the long tube, *b*. The mercury in falling acts exactly as though it were a succession of small pistons, following each other rapidly, and each one forcing a bubble of air down and out through the long tube and circulating

* The *Electrical World* (New York).

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pipe, *f*. The consequence of this is for the first few minutes that the lamp is on the pump, the column of mercury in the tube *b* is full of falling bubbles, and as the process continues the bulbs get smaller and smaller, and fewer in number, giving a very good ocular demonstration of the progress of the exhaustion. Very soon the tube will appear solid—that is, with no bubbles—indicating that no more air can be forced out under the existing circumstances. The vacuum is, however, far from complete, there still being a considerable quantity of air clinging to the glass and to the filament. In addition to this, the filament itself and the clamps contain gases which must be driven out before the vacuum is complete. Up to this point no current has been allowed to traverse the filament, the lamp being consequently cold. Resistances are placed in series with each lamp, and by means of a small plug, *s s* (Fig. 5), can be thrown in or out, regulating the amount of current passing through the filament. The lamp is now allowed to burn at a dull red for several minutes. This heats the lamp, and some of the air clinging to the glass is forced out and caught by the falling mercury. The column of mercury, which had previously become solid, now becomes filled once more with bubbles, though much smaller than before. Some of the gases are also driven out of the filament and clamps. When the bubbles have nearly ceased again the lamp is flashed, and then allowed to burn, driving more air and

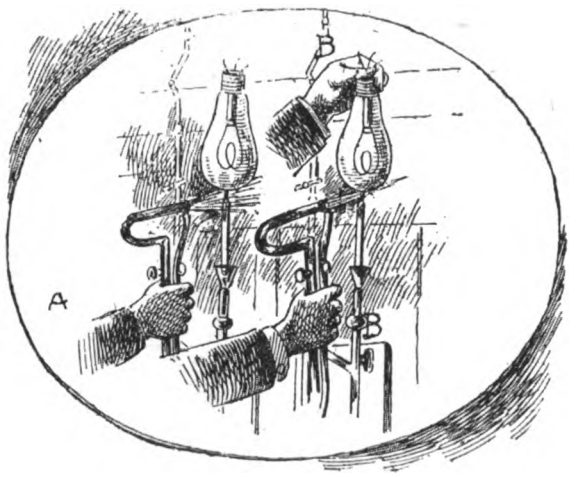

FIG. 6.—Sealing-off.

gases out. This process is repeated until the lamps are all burning at something above normal candle-power, and when the mercury tube once more appears solid and free from bubbles, the vacuum may be considered attained.

The next operation is known as "sealing off," and consists in taking the lamps off the pumps without losing the vacuum. This process is indicated in Fig. 6, the dull flame being for the purpose of gradually heating the glass, and the hot pointed flame doing the work. The operator holds the blow-pipe in the left hand, and with his right lifts the lamp off as the glass melts.

The lamp is now ready for basing, though as a rule this is not the next step which it undergoes. The natural order would at first sight seem to be to base the lamp and then to test it, but commercial considerations renders this impossible. Lamps are manufactured with so many different bases—the Edison, Thomson-Houston, Westinghouse, Mather, Hawkeye, Brush, Swan, etc.—that it would require a stock of millions of lamps to supply only a moderate demand at short notice. By carrying them in "wire-stock," however, this difficulty is overcome in a great measure, the lamps being based to order. As the method of testing, however, is the same whether the lamp is based or unbased (wire lamp), it will be best to finish the manufacture first and describe the testing after. Fig. 7 shows the various stages of socketing: 1 is the frame consisting of a long bench, perforated with circular holes, which receive the mould, 2. The mould is made in two sections to admit of the lamp being more easily removed. The Edison base consists of two parts—the button and the shell. These having been placed in the mould, the lamp is laid on the frame, as shown in Sketch 4, Fig. 7. The wires are so arranged that one is in contact with the button, the other with the outer shell. Plaster is then poured in the mould, filling the base. The lamps are then raised to a vertical position, and forced by hand into the plaster, and a small vertical hollow rod pushed down over the small projection on the end of the bulb; this serves to keep it straight and steady it while the plaster hardens (see 5, Fig. 7). The lamps are then placed in a drier, as damp plaster causes short-circuiting, moisture being a fair conductor.

The lamps are now ready for the photometer test. A great deal of mystery seems to surround this test in the minds of many people, though it is exceeding simple in principle. Nevertheless, too much care cannot be taken with this test, and it is necessary to employ the best of labour. Although I have stated that the principle is simple, I do not by any means wish to be understood to imply that a successful photometer test can be made by anyone. On the contrary, an inexperienced person would be very apt to find his readings differing by several candles when there should be, and probably is, no practical difference. The photometer is shown in Fig. 8, and consists of a long bar, to the centre of which is attached a screen, shown in 2, and is simply a rectangular frame holding a disc of paper, in the middle of which is a grease spot, A. On either side of this disc are fixed small mirrors, B B, at an angle so that an observer looking at A

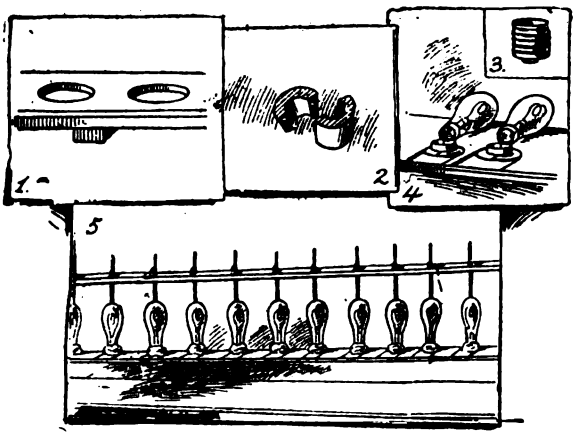

FIG. 7.—Socketing.—1. Frame.—2. Mould.—3. Shell.—4. Lamps ready for Plaster.—5. In Plaster. Hardening

on edge sees two reflections of the grease spot in the mirrors, B B. On top of the photometer is the galvanometer for keeping the voltage constant, and on the photometer bench can be seen the ammeter (under the screen) and the voltmeter, near the lamp to be tested. At the opposite end of the photometer bar is shown the standard lamp.

In many factories only a comparatively small percentage of the total product is tested on the photometer, the balance of the lamps being placed on racks with some of those tested, and sorted out by means of the eye. This method is, however, unsatisfactory, though it gives much closer results than is apt to be supposed. Much better results can be secured by testing each individual lamp, which method, though expensive, is thoroughly reliable.

The standard of candle-power varies, and is different in the United States and in Europe; and, in fact, were the same lamp sent to different laboratories throughout this country, quite a variety of results might be expected. The original standard, or unit of light, may be the flame of a candle or a portion of the flame of an Argand burner. In comparing standards with the original unit of light, the Methven screen is used, which allows only a small portion of the centre of the flame to shine on the grease spot of the photometer, this part of the flame remaining more nearly constant. In the factory, however, standard lamps of different candle-power are manufactured and kept constantly checked up, new ones being made up from time to time. In order to test a lamp, a standard lamp, say, of 16 c.p., is placed at one end of the photometer bar, the voltage of this standard being kept absolutely constant. The lamp to be tested is mounted at the other end of the

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photometer, the screen and mirrors being in the middle, and equidistant from the lamps. In shunt with the lamp to be tested is a voltmeter, and in series with it an ammeter, the latter being used only where the efficiency is to be tested or when the lamp is destined for series work. One operator sits directly in front of the screen, and by moving a slider changes a resistance in series with the lamp to be tested. This alters the amount of current passing through the lamp, and consequently the amount of light given out by it. The operator at the same time is watching the reflections of the grease spot in the mirrors. As long as the intensity of light on the two sides of the spot is unequal, the reflections will be quite different in appearance—one being dark, the other light When the intensity of the lamp to be tested is exactly equal to that of the standard 16-c.p. lamp at the other end of the photometer, the images of the grease spot become exactly alike in appearance, and, in fact, almost entirely disappear. The other operator reads the voltage as indicated by the voltmeter, and the lamp is so marked. Care must be taken that the standard is mounted in its socket at the exact angle at which it was originally standardised, as the intensity of light varies with the angle which the plane of the filament presents to the photometer bar. For the sake of uniformity, all lamps are tested with the filaments in the same relative position to the photometer, otherwise it would be impossible to compare results or check the test.

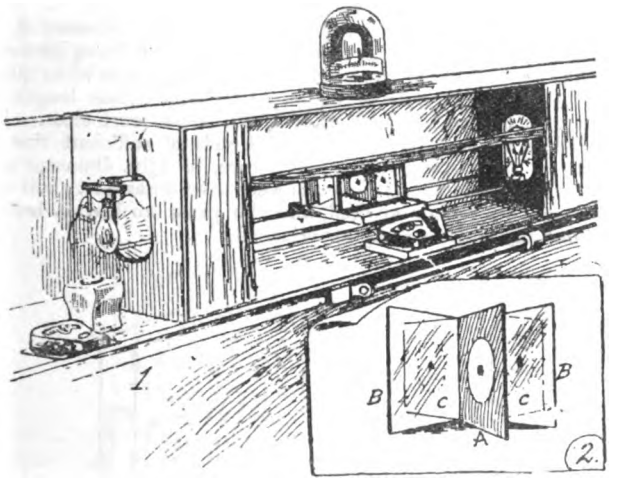

FIG. 8.—1. Photometer.—2. Disc and Mirrors.

This is so important a subject, and so many practical points are involved in it affecting the user of lamps, that I regret more space cannot be devoted to it, especially as at the present time many large consumers of lamps are fitting up photometers with the idea in view of testing the product of factories. This is undoubtedly a very sensible plan; nevertheless, there is trouble in store for all of us until the use of the photometer is thoroughly understood. At the lamp works of the General Electric Company, every lamp is tested on the photometer, and before shipment, an additional test, known as the rack test, is applied. This, briefly, consists in placing the lamps in a long horizontal rack and passing a low current through them, bringing them all to a dull red. In this position it is very easy to pick out any lamps showing defective filaments, such as spotted carbons. These are weeded out and the voltage raised until the lamps are all burning at about normal candle-power. The percentage of lamps thus weeded out is very small, because after every process in the factory expert inspection is made of the product, making about 70 inspections in all. Another source of possible error is at once detected on the rack—namely, mixing lamps of different candle-powers, caused by errors in making. It seems rather a curious fact that if two lamps, one of 16 c.p., the other of 20 c.p., but both of the same efficiency, were placed side by side, it would be extremely doubtful whether the difference would be noticed by any but the most experienced eye; on the other hand, place two 16-c.p. lamps together, of different efficiencies, and the disparity can be readily detected, though they are of the same candle-power. On the rack test nearly all errors are apt to be discovered, because since the lamps are all at the same voltage, any error appears at once at a difference in efficiency, except in the case of two lamps of the same efficiency, same voltage, and different candle-power. This is so improbable an error that its occurrence need not be considered. To explain what is meant, let us suppose two filaments, one very small and fine, giving 10 candles of light, and consuming 30 watts, or three watts per candle; the other, very large and coarse, giving 20 candles, consuming 200 watts, or 10 watts per candle. The small filament would burn very white and would apparently be giving much more light than the coarse filament, which would burn very dull. The surface of the latter filament being so much greater, it is really giving out twice as much light. The lamps which are not kept barrelled up are carried in the factory in racks each containing a certain number of lamps, and are of great assistance in counting. A miscount in shipment is very rare. The lamps have now only to be cleaned, labelled, and wrapped, and they are ready for barrelling up.

It is sometimes disheartening, after all the care taken in the manufacture of the lamps, to hear the complaints made by owners of plants, which in nine cases out of ten (and this is not in the least an exaggeration) are due to some misuse of the lamps. To begin with, a lamp should be fitted to a plant's pressure, just as much as a shoe to give satisfaction should be fitted to a man's foot, and after the

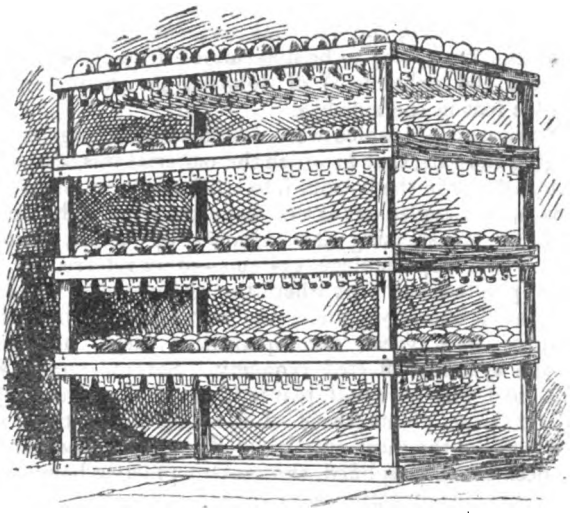

FIG. 9.—Lamps in Rack ready for Barrelling.

lamp is so adjusted to the requirements, the regulation should be kept constant. In no other way can lamps, no matter of what manufacture, give satisfaction. Good regulation means running the plant within one volt either side of the marked voltage of the lamps. This can be appreciated when it is understood that to run a lamp four volts above its voltage shortens its life to exactly one-half; eight volts high reduces the life to one-quarter. In other words, a 100-volt lamp whose normal life is 1,000 hours, if burned at 104 volts will live 500 hours, and if subjected to 108 volts will only burn 250 hours. I have tested plants supposed to be running at 104 volts, which showed on test to be really 120 volts. Imagine the effect on the lamps! It is not at all an uncommon thing for plants to vary the regulation 10 or 15 volts; in fact, the only uncommon thing in the business is to find good regulation outside of the very large illuminating companies, and even there it is by no means perfect. It being the season of the year when good resolutions are in order, let us resolve "to keep our regulation perfect."

THE EXTRACTION OF GOLD BY THE CYANIDE PROCESS.

A paper on this subject was read on Tuesday before the Institution of Civil Engineers by Messrs. Charles Butters and Edgar Smart, A.M.I.C.E., Sir Douglas Fox, vice-president, being in the chair.

The "cyanide" process of extracting gold from ores and tailings, in which the gold, after being dissolved by

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cyanide of potassium, was precipitated from the solution by zinc shavings or electricity, was first briefly described. For plant to carry the process into effect, it was shown that the best site was one having a fairly steep and uniform slope downwards from the material to be treated, for this not only allowed the lip of the treatment vats to be placed below the level of the tailings, which might therefore be run into them by gravity, but also gave plenty of space below the works for dumping the residues after treatment. Typical examples were described and illustrated of works built upon convenient and inconvenient sites. The size and number of vats were stated to depend not only upon the quantity of material to be treated in a given time, but also on the time occupied in filling and discharging the vats and in leaching. The zinc process occupied a period of between 60 and 84 hours, so that with the time for the filling and discharging a complete cycle of operations was performed in just four days and night. A longer period of 110 hours was required for the Siemens-Halske electrical process on account of the weak solution of the cyanide with which it could be worked. A larger size for the vats than 600 tons capacity was not recommended by the authors, but up to that limit they had found a few large vats to be more convenient than a large number of small ones. For a plant with five vats, each of 600 tons capacity, the sizes of the alkaline-wash, strong-solution, and weak-solution tanks were given as 300 tons, 300 tons, and 450 tons respectively. The capacity of the zinc-boxes was to be determined from the rule that each ton (26 cubic feet) of solution per hour required 21 cubic feet in the zinc-box.

Of the methods which were described of filling and discharging the vats, that in which the material was discharged through doors in the bottom into trucks running in a tunnel beneath, was singled out as that to be preferred. The various means of transporting the tailings—by mules, hauling-engines and rope-haulage systems—were referred to, and it was pointed out that where the tailings were scattered the use of hauling-engines was advantageous, but where distances were great and quantities large, mechanical haulage systems effected economy. Several pumps were mentioned, but for small plants those of the donkey type, and for large plants those of the centrifugal type, were described as the most suitable. The piping arrangements had been much simplified, the present practice being to use one large pipe connecting, with separate cocks, all the solution tanks to all the leaching-tanks, through a centrifugal pump, when necessary. Iron plug cocks were stated to be unsuitable for the work on account of the film of oil being dissolved by the caustic potash which resulted from the process, and packed case valve was referred to as the only type which could be used with safety. Suitable sizes for the charging and leaching pipes for different diameters of vats were given.

The usual method of collecting sand and slimes by means of "tailing dams" was described, and its results upon their distribution and character in regard to future treatment were considered. It was demonstrated how it was possible, and of common occurrence, for slime lumps to assay higher after treatment than before it, on account of their absorbing the solution which had dissolved gold from the sand and retaining it occluded in their masses. Methods of ploughing, harrowing, and shovelling were mentioned for reducing the dry slimes to fine powder, and various forms of disintegrating machines for the same purpose were described, and the advantage was emphasised of dealing with the tailings directly they leave the battery. Particulars were given of the system worked out by the authors in conjunction with Captain Mein, in which collecting-vats, having filters and bottom discharge doors, the water running off over the whole periphery of the vat into a trough which conducted it to the slime pits, were used. The best form of distributor was described, and the sizes for the vats which had been found most effective in practice were tabulated. Brief mention was then made of some trial methods for shine treatment. Descriptions followed of four works which had been chosen as typical examples of the application of the plant to the varying conditions found in each case.

The Main Reef Cyanide Works, designed to treat 7,000 tons of tailings per month by the zinc process, and built in April, 1893, was first described, and particulars were here given of the method of construction and materials of the vats and zinc-boxes. The Princess and the Simmer and Jack Cyanide Works of 3,000 and 15,000 tons per month capacity, respectively, both using the zinc process, were next dealt with; and with reference to the latter, in which were the largest wooden leaching-tanks on the Witwatersrand goldfields, further particulars were furnished of the construction of the tanks, discharge doors, and furnaces for roasting the slimes. The process of cleaning up the gold by the zinc precipitation process was also described. The paper concluded with an account of the Worcester Cyanide Works, at which the Siemens-Halske electrical extraction process was in operation, details being given of the electrical boxes and of the method of the recovery of the gold from them.

THE APPLICATION OF THE ELECTRIC ARC SYSTEM OF WELDING TO MACHINERY AND BOILER REPAIRS.*

BY HENRY FOSTER.

(Concluded from page 198.)

Fig. 8 represents in detail the drawback piston and piston-rod of a Davy 2,000 tons hydraulic forging press. When working it was found that the drawback piston-rod, *a b*, was 10in. too long at end *b* to admit of forgemen's cutters, etc., being readily used, and as the swelled portion of piston-rod at end *b* was only 9¼in. long, it did not admit of being screwed further up and at the same time suit existing nuts when 10in. had been cut off ends of piston-rods. The excess length of 10in. was, however, cut off, after which bosses were electrically welded on to the 4¼in. diameter shaft ends of sufficient size to admit of their being turned, as before, to 4¾in. diameter and 9¼in. long. The piston-rod ends were then screwed to suit old nuts and afterwards erected, and the press worked as before without any trouble being experienced.

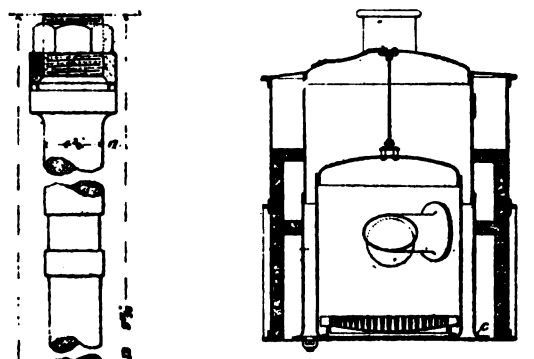

FIG. 9.

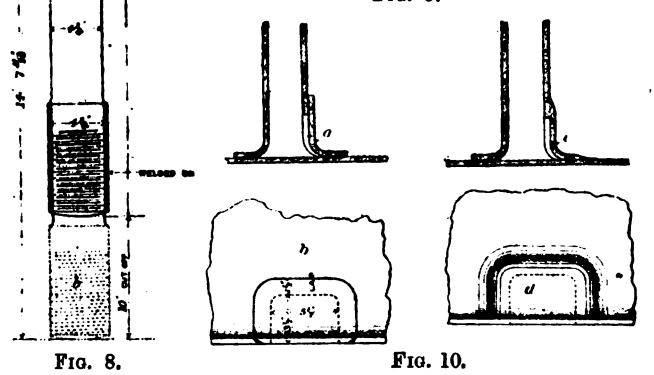

FIG. 8. FIG. 10.

Apart from the general work done at Newburn by this process in the repair of slightly defective steel castings, many other instances might be cited where repairs of a similar nature to those already described have been done; such, for instance, as welding in the teeth of cast-steel wheels which have been broken out while working, without removing the wheels from their shafts; but one more example must suffice before proceeding to treat of the application of the process to boiler repairs.

STEAM-BOILER REPAIRS.

The first application of the process of electric arc welding in connection with steam-boiler repairs at Newburn was made in September, 1891, upon a boiler supplied by Messrs. Joseph

* Paper read before the North-East Coast Institution of Engineers and Shipbuilders.

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Booth and Bros., Rodley, near Leeds, for driving one of their 35-ton overhead steam-cranes, and shown in sectional elevation by Fig. 9. This boiler, which is eminently adapted for raising a large volume of steam in a limited space, is provided with an outer casing lined with firebrick, built in the form of flues, which completely encircle the outer shell of the boiler, so that the hot gases from the fire are compelled to pass entirely round and in contact with the outer shell before escaping at the chimney.

The defect, which was situated at *c*, Fig. 9, where the outer shell of boiler is riveted to bottom plate, had originally existed as a leak, which, not being visible from the outside, had caused considerable corrosion at this point before it was discovered, and when the corroded parts had been cut away to full plate thickness, a hole was left in the outer shell, 5½in. long by 3½in. deep, and extending round the bottom flange of outer shell in the immediate vicinity—a somewhat difficult place to fix a patch without removing the internal firebox. Before commencing to electrically weld the defect, a piece of mild-steel plate was neatly bent and dressed to fit the outside of the boiler shell and bottom plate, as shown in sectional and front elevation at *a* and *b*, Fig. 10, and having 1½in. lap all round the hole. The patch plate was then laid in position over the hole, and the electric arc struck upon the junction of the patch and boiler shell, so as to melt together and thoroughly incorporate the lap of the patch with the boiler shell and bottom plate which it overlapped, and under the action of the electric arc the outer edges of the patch plate were gradually drawn away to nothing, and made to loose themselves in the boiler shell and bottom plate, as shown in sectional and front elevation at *c* and *d*, Fig. 10. The internal firebox was not removed or otherwise disturbed to facilitate the work, and after being welded, the boiler was tested under hydraulic pressure to 140lb. per square inch and found perfectly tight, the whole operation of fitting the plate, welding, and testing the boiler only occupying 10 hours. Since being electrically welded, now nearly 3½

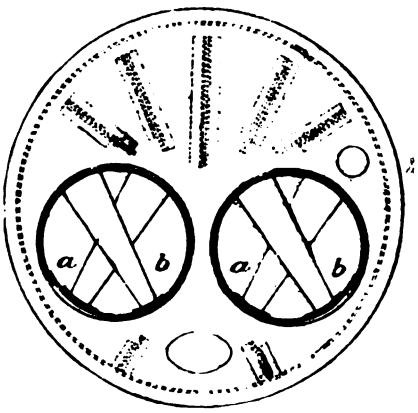

FIG. 11.

years ago, this boiler has been in constant use at the original stipulated steam pressure of 70lb. per square inch for six days per week, without showing the slightest indication of fatigue.

Fig. 11 is an end elevation of Lancashire boiler 28ft. long by 7ft. 6in. diameter. Four of these, numbered respectively 5, 6, 7, and 8, owing to defective construction of flues and furnaces, have given considerable trouble in working. In these boilers (which were constructed for a working pressure of 100lb. per square inch) the different lengths of flue, instead of being welded and made truly cylindrical, are each formed with single riveted lap joints below firebar level, and the alternate lengths made to break joint at *a* and *b*, Fig. 11, and joined together by Bowling hoops as shown. Where the lap joints of flues make joint with Bowling hoops, they are drawn to a fine edge, and with the expansion and contraction of the flues under pressure, a heavy stress is brought to bear upon the Bowling hoops in the immediate neighbourhood of the joints, with the result that the Bowling hoops crack in the corners, as shown at *a*, Fig. 12, through a certain portion of their circumference immediately opposite the longitudinal joints in the flues—the cracks in every instance being in the corner adjacent to the lap joint—and although not immediately dangerous, the working of boilers had to be discontinued owing to excessive leakage. To fit new flues, or even to fit new joint rings in place of Bowling hoops, would have necessitated the boiler fronts being taken off, which, irrespective of the expense, in this case implied that part of the working plant must stop for want of steam.

The trouble commenced with No. 8 boiler in September, 1893, and in the first instance was confined to one boiler only and one Bowling hoop, the crack being 13in. long, and extending about even distance on either side of flue joint. It was proposed to electrically weld the defect *in situ*, but before doing so the Boiler Insurance Company were requested to allow their inspector to attend and witness the process of electric arc welding as carried on in another department of the works, and satisfy himself as to the feasibility of the proposal. This being done, the boiler was electrically welded as follows: A pair of ordinary electric cables were procured, of sufficient length to reach from the electric lighting dynamo to the boiler, and of sufficient size to carry the necessary current. One end of cable No. 1 was attached to the positive terminal of the dynamo, and its other end to the boiler manway cover; while one end of cable No. 2 was attached to the negative terminal of the dynamo, and its other end to the resistances, which in this case, as in others already cited, consisted of a number of ordinary arc lamp resistance coils. From the resistance coils a flexible cable was carried over the boiler front and into the boiler flue, and terminated at the carbon-holder held by the workman. The crack was then gouged out, and welded up by inserting small nuggets of mild steel and melting them under the influence of the electric arc and gradually incorporating the new material with the old in the vicinity of the line of fracture, the form of finished weld being shown at *b*, Fig. 12, where the shaded portion indicates new material added. The welding operation occupied about five hours, and, when completed, the boiler was tested under water pressure to 150lb. per square inch, and found perfectly tight, and steam was raised in this boiler on the following day.

Exactly the same trouble as that above recorded was experienced with No. 6, 7, and 8 boilers in October, 1893, the crack in Bowling hoop of No. 8 boiler being at opposite side of flue to that previously welded. No. 6 boiler was electrically welded on Saturday, October 14, No. 7 on Sunday, October 15, and No. 8 on Monday, October 16, and, after being tested under water pressure, as before, were all working under full steam pressure at 6 a.m. on October 17. In the case of No. 8 boiler,

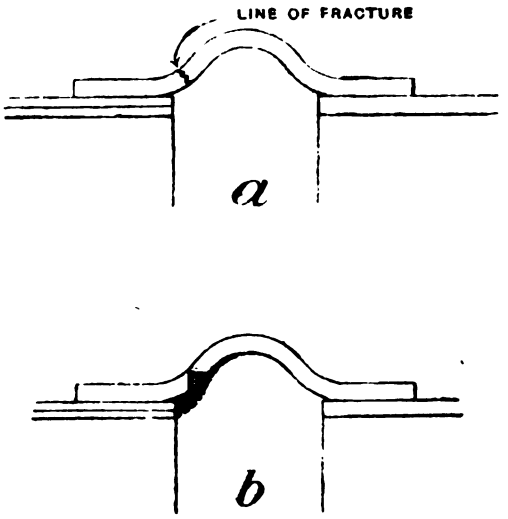

FIG. 12.

the exact time occupied in welding the crack (5in. long) was recorded as follows:

Boiler blown off at.....	1.30 p.m.
Commenced to electric weld at	3.0 ,,
Welding completed at	4.30 ,,

All the boilers continued to work almost without interruption and without trouble being experienced until August and September, 1894, when very heavy firing was necessary to meet the increased demands for steam, and it was again found necessary to electrically weld the boilers as follows:

August 11.—Electrically-welded Bowling hoop of No. 5 boiler, crack 4½in. long.

August 12.—Electrically-welded Bowling hoop of No. 6 boiler, crack 11½in. long.

September 1.—Electrically-welded Bowling hoop of No. 6 boiler, crack 3½in. long.

September 17.—Electrically-welded Bowling hoop of No. 6 boiler, crack 1½in. long.

September 17.—Electrically-welded Bowling hoop of No. 7 boiler, crack 10¾in. long (left-hand tube).

September 17.—Electrically-welded Bowling hoop of No. 7 boiler, crack 2in. long (right-hand tube).

In two or three instances cracks have again occurred through the electrically-welded joints, but this has always been directly opposite the longitudinal seams of the tubes where fracture of original hoops took place; and from experience gained in welding these defects and carefully noting their behaviour, the writer is of opinion that by electrically welding the Bowling hoop and tube together in the immediate neighbourhood of the junction of longitudinal seams with the Bowling hoops, and slightly increasing the total thickness at this part by building up and thereby stiffening the joint, the trouble can be entirely overcome, if this has not already been done, seeing that it has

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not been again necessary to weld the joints since September, 1894.

Cutting and Boring.

Another very simple application of the electric arc is that of cutting and boring metals roughly to shape, and in work of this kind the same methods of procedure apply as in all the other cases cited—viz., that the article to be cut is made to form one pole, and the carbon pencil the other pole. Under these conditions, if the carbon pencil is brought in contact with the metal to be operated upon, an arc is immediately struck between the carbon pencil and that part of the metal in contact with it at the time, with the result that the metal is instantly melted in the immediate vicinity of the arc, and may be allowed to flow away as it is melted. In this way holes may be pierced in steel, iron, or other plates with great rapidity, and by moving the arc gradually along the holes may be elongated into slits of any required length or shape at the option of the workman.

Fig. 13 shows a wrought-iron tube sunk in the river bank and surrounded with broken slag and gravel. The object of this tube is to form a large strum from which water may be pumped at all states of the tide, and originally it was lying in stock as a plain tube without holes in side plates. The tube, as shown, was sent to the electric welding shop at 8 a.m., and between that time and four o'clock on the afternoon of the same day 304 holes, each about 1in. diameter, had been pierced through the 5-16in. thick side plates, the actual rate when working being between two and three holes pierced per minute.

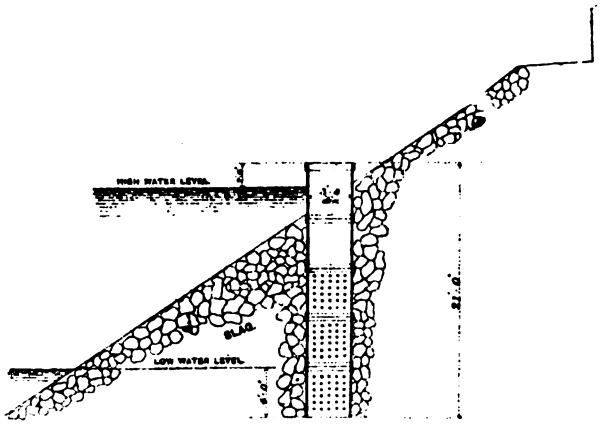

Fig. 13.

Many other illustrations of the application of the electric arc to cutting and boring *in situ* might be given, but doubtless sufficient examples have been recorded to illustrate the general utility of its application to work of a similar nature.

Plant and Apparatus Required.

The plant and apparatus necessary to effect all ordinary repairs, or to perform the operations of cutting and boring as described, may be of the simplest description, and in places where an ordinary low-tension electric arc lighting installation is in operation practically everything necessary is in stock. In any case, however, where the necessary plant has to be provided for arc or incandescent lighting, it may be arranged as follows, and made to serve the double purpose of lighting during the night, and welding, etc., during the day as desired, providing both duties are not required at one and the same time.

A combined engine and boiler of the type frequently supplied for driving dynamos in connection with electric lighting installations and equally well adapted for welding purposes, may be put down. The dynamo in this case should be of the ordinary compound-wound type, and capable of giving a continuous current of not necessarily more than 500 amperes, but certainly not less than 300 amperes, at a pressure of 65 to 95 volts, the best welding results when working on steel or iron being apparently obtained with 500 amperes at 80 volts pressure. The cable attached to the positive terminal of the dynamo should be carried without interruption, as shown by Fig. 14, direct from the dynamo to the article, *c*, required to be welded or otherwise operated upon, and electrical connection made by attaching the uncovered end of cable to the iron table on which the work lies, or it may be attached to the work itself. At any convenient point between the dynamo and the workman's carbon-holder, *b*, the negative cable should be divided, and resistances, *a a*, interposed as shown, except in special cases where the cables are sufficiently long to render resistances unnecessary. The resistances may be composed of a number of bars of iron, wound in the form of helical springs to reduce the space occupied, or, preferably, the resistance coils ordinarily used in connection with the arc lamps may be utilised and arranged as shown by Fig. 14, the only necessary condition being that sufficient resistance be interposed to ensure a steady continuous arc at the operator's carbon, *b*, and in all ordinary cases this will be obtained by a drop in the voltage of that portion of the negative cable lying between the resistances and the operator's carbon, as compared with that portion lying between the negative terminal of the dynamo and the resistances, of about 30 to 35 per cent.; or, in other words, if the pressure at dynamo be, say, 80 volts, the pressure at operator's carbon should be, say, 52 to 56 volts to ensure a steady and continuous working arc, and this will generally be obtained by interposing from 24 to 28 ordinary 3,000-c.p. arc lamp resistance coils, as shown at Fig. 14.

Of course, a very much more portable and equally efficient regulating resistance may be arranged, but in this case cited it is assumed that only the arc lamp resistance coils are at hand. A short portion of the cable to which the operator's carbon-holder is attached should be flexible, so as to admit of easy manipulation of the arc, and as light as possible consistent with

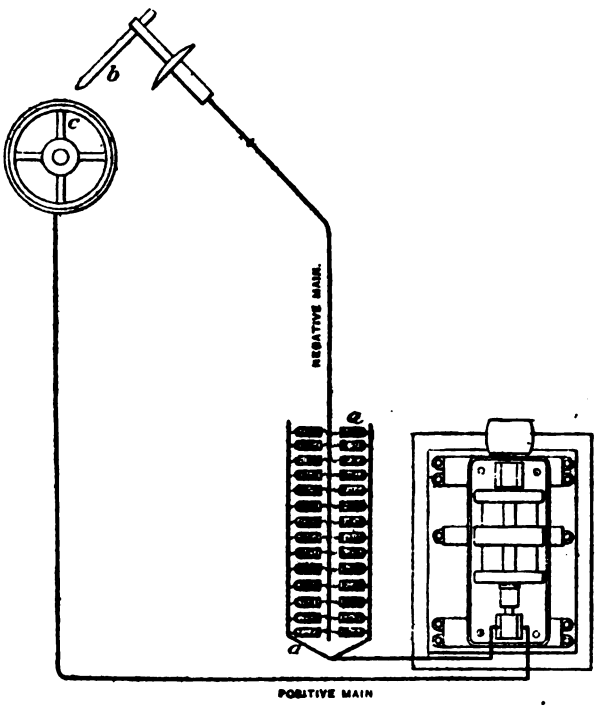

Fig. 14.

its carrying the necessary current without undue heating. The face and eyes of the workman must in all cases be protected, that portion of the protector covering the eyes being of coloured glass, preferably in three separate thicknesses, and composed of two red pieces, occupying the back and front, with a blue piece interposed between them; for if the eyes are exposed even momentarily to the full glare of a large arc, an effect is produced upon the muscles of the eye which, though not permanently injurious, or of more than a few hours' duration, is very painful and disagreeable while it lasts. The effect produced upon the face or other tender portions of the skin by exposure to the radiant energy of the arc, for any length of time—although not felt at the time of exposure—is similar to that produced by a very severe sun-burn, and also painful when an attempt is made to wash the parts with soap. With these precautions taken, no trouble has ever been experienced, and the same men are now at work welding who have been associated with the process since its installation, and with such a low E.M.F. it is impossible to get a dangerous or even unpleasant shock, consequently the machine or articles in circuit may be handled with impunity, and all the operations of welding, etc., carried on with the workman sitting or lying upon the articles being welded.

Necessary Precautions to Ensure Sound Welds.

1. The carbons used should be "uncoppered" and of one uniform quality, sound, and hard, and having a metallic ring when struck, and must burn with little or no dust deposit, otherwise the finely-divided carbon deposited on the weld may be absorbed by the metal, which will thereby be rendered brittle. 2. When "building up," the metal introduced into the weld should be as nearly as possible of the same composition as that of the article to which it is welded, and the workman should remove the slag formed on the surface of the weld from each layer added before commencing to add another one. In cases where the part to be "built up" projects above the neighbouring surface (as for instance, a wheel tooth), each layer of material added should be retained in position and prevented from flowing away while in a molten state, and this is best done—previous to the addition of each layer—by forming a ridge of finely-ground gannister clay round the circumference of the layer to be added. 3. When the metal in the vicinity of the arc has been under the action of the arc for a short

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space of time, the heat gradually extends by conduction to the metal in the neighbourhood of the part operated upon, whereby the resistance of the metal to the passage of the current is increased, and, in consequence, admits of a longer arc being obtained than under conditions where the metal in the vicinity of the part operated upon is not so heated; and the workman should always endeavour to obtain these conditions of heating of the surrounding metal, and to finish off each layer under the action of a long and steady arc, so as to ensure the gradual solidification of the metal added, and its subsequent annealing by the gradual radiation of the heat from the part operated upon, when the carbon is eventually withdrawn and the arc broken. 4. In all cases where it is possible to do so, each layer of new material added should be hammered immediately the carbon is withdrawn and the arc broken; and where this is not possible, the withdrawal of the carbon and breaking of the arc should be gradual, for reasons already stated.

QUALITY OF WORK DONE BY THE BENARDOS PROCESS.

In order that the capabilities of the Benardos process of electric arc welding in relation to the quality of work done might be placed beyond doubt, Mr. Henry Lea, the well-known electrical engineer, of Birmingham, was requested by Messrs. Lloyd and Lloyd to conduct for them an investigation in conjunction with Messrs. David Kirkaldy and Son, of London. For this purpose 210 bars of varying thicknesses and qualities of iron and steel were electrically heated and welded by ordinary workmen (not trained smiths), and, together with 50 bars welded by good engine-smiths in the employment of another firm out of a coke fire in the usual way, were submitted to Messrs. Kirkaldy to be tested. In the results, as reported by them, the "average ratio of weld to solid" of the 150 electrically-heated iron bars equalled 85·5 per cent., and of the 60 steel welds 80·8 per cent. In every case 10 welds of each size were tested. A comparison between the results obtained from the hand-welded bars and those which were electrically heated will show that in every case the latter give a higher "ratio of weld to solid" than the former. In other respects, also, the comparison is usually favourable to the electrically-heated bars. These experiments are believed to be the first attempt to demonstrate scientifically the value of the arc as a heater of iron and steel for welding purposes. It must be remembered, however, that the results shown were obtained by comparatively unskilled hands, and could be materially improved by continuous practice. The economy of arc heating in the manufacture at Coombs Wood and elsewhere of various articles is established beyond doubt.

In conclusion, the writer begs to point out that this process of electric arc welding is not proposed as a substitute in all cases for the ordinary methods of welding now in use, nor is it proposed as a substitute for riveting in the manufacture of high-pressure boilers, but rather as an additional method, capable of very extensive application under conditions where the ordinary methods of welding are inapplicable. The simplicity of the process, and the ease with which the working apparatus can be transported to the place required, combined with the nature of the work capable of being accomplished, as illustrated by the numerous examples given, are, in the writer's opinion, sufficient reasons for its more extended application; and the writer respectfully submits that it is difficult to conceive a more useful application of the process of electric arc welding than that which would be obtained from a small steam craft with the necessary welding plant and cables on board, and capable of plying up and down the river and effecting repairs of the nature of those illustrated, either in the works adjacent to the river while lying alongside a wharf or on board a ship when moored close by.

THE CANNON STREET EXPLOSION.

BOARD OF TRADE REPORT.

(Concluded from page 201.)

APPENDIX I.

(From the *Proceedings* of the Royal Society, vol. 56.)

"On the Difference of Potential that may be established at the Surface of the Ground immediately above, and at various distances from, a Buried Mass of Metal charged from a High-Pressure Electric Light Supply." By Major Cardew, R.E., and Major Bagnold, R.E. Communicated by Lord Kelvin, P.R.S. Received June 24, 1894.

On January 8, 1894, an accident occurred at Bournemouth of an unusual nature. An omnibus was in the act of drawing up in the roadway outside the Imperial Hotel, when the horses suddenly fell down, and one of them died in a few minutes. All the men who assisted in extricating the horses felt tingling sensations in their limbs suggestive of electrical shock, and the connection from the mains of the Bournemouth Electric Light Company to the hotel was known to pass underneath the spot at which the accident occurred. This company use the high-pressure alternating system at 2,000 volts pressure, and in the case of this hotel the transformers were installed upon the premises.

On investigation, a defect in the insulation of one of the high-pressure service lines was discovered, from which sparking had evidently taken place to the enclosing 1½in. wrought-iron pipe. This pipe was 32ft. long, laid at a depth of about 18in., and terminated at a brick junction-box under the roadway and a brick and cement area wall at the hotel. The ends were thus fairly insulated, while the rest of the pipe was in contact with the earth. The accident took place during the progress of a thaw after a very severe frost.

Upon consideration of the case, Major Cardew reported to the Board of Trade that in his opinion the accident was caused by leakage from the short length of charged pipe, affecting the potential of the surface of the ground to such an extent that between the fore and hind feet of the horse a sufficient difference of potential was established to give rise to the current which proved fatal. At the same time, as the fact of such a result following from a simple contact with ordinary road material was a new experience of the possible dangers attending the commercial supply of electrical energy, it was thought desirable to repeat the conditions as nearly as possible, and measure the results obtained. As such an experiment could not, for obvious reasons, be satisfactorily carried out in London, it was arranged that it should be tried at Chatham, where the necessary apparatus was available.

A first experiment was made on January 26, 1894. In this a length of 33ft. 3in. of 2in. iron pipe was buried to a depth of 18in. within the salient of one of the demi-bastions of St. Mary's Barracks, Chatham. A piece of well-insulated 37-strand No. 16 cable was inserted in this pipe so that the ends of the conductors made good contact with the inside of the pipe at its centre point. Over the centre of pipe two 56lb. weights were placed on the surface of the ground, and at a distance of 4ft. laterally another pair of 56lb. weights were similarly placed. A 16-kilowatt alternator was connected by mean of an underground cable laid in stoneware pipes to the piece of cable in the 2in. pipe. The other pole of the alternator was connected to a 1½in. service pipe in connection with the barrack water-mains. One end of this service pipe was in connection with a hydraulic ram set in the ground at a distance of 140ft. from the piece of buried pipe. An 800-volt Thomson static voltmeter was connected across the terminals of the alternator, and a pair of leads well insulated were attached by means of screws to the two pair of weights situated over the buried pipe. These leads were ran back together to the experiment-room, and were connected alternately to a 140-volt static voltmeter and a Cardew voltmeter.

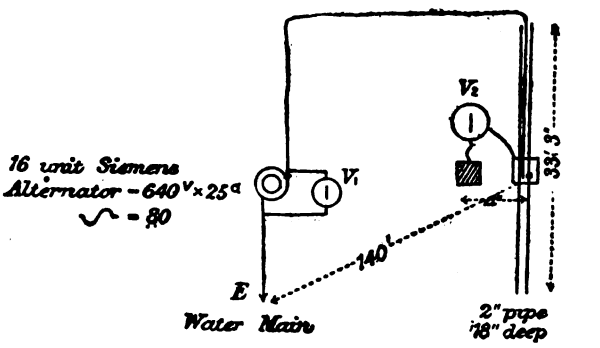

FIG. 1.

The voltage of the alternator was varied by means of the exciting current, which was taken from accumulators. The readings on both voltmeters are given in Table I. As the earth resistance was rather low, the alternator could not be run up above 400 volts without overheating the armature. Fig. 1 is a diagram of the arrangement.

TABLE I.—Experiment of January 26, 1894.

Readings of statical voltmeter on terminals of alternator.	Readings across weights.		Remarks.
	On Cardew voltmeter.	On statical voltmeter.	
294	—	62	Resistance of earth circuit before run, 17 ohms.
290	—	61	
305	30	—	
310	30	—	
375	38	—	Distance between weights, 4ft.; weights, each, 2/56lb.
380	40	—	
400	43	—	
390	—	83	
375	—	81	Soil loamy and very wet.
385	—	82·5	
390	—	83	About 80 periods per second.
394	—	84	
400	—	86	
398	—	85	
400	—	86	
403	—	87 5	

The results show a potential difference between points 4tf. apart on the surface of over 20 per cent. of the whole potential difference used to charge the pipe when measured statically, and even when a current of nearly $\frac{1}{10}$ ampere was drawn from the

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ground through a Cardew voltmeter the potential difference was more than 10 per cent. of the whole.

The propinquity of the scarp walls, however, appeared likely to have, to some extent, influenced the direction of the lines of flow of current, and it was determined to repeat it, changing the position of the pipe and extending the tests to a greater distance from the pipe. The second experiment was carried out on March 16, 1894. The arrangements are shown on Fig. 2, and the results given in Table II. The statical potential differences to be observed extended rather beyond the range of one voltmeter. Thus, between weights A and B no statical observations could be taken beyond a charging pressure of 440 volts, while between weights C and D the potential difference, even with 610-volt charging pressure, was too small for exact measurement.

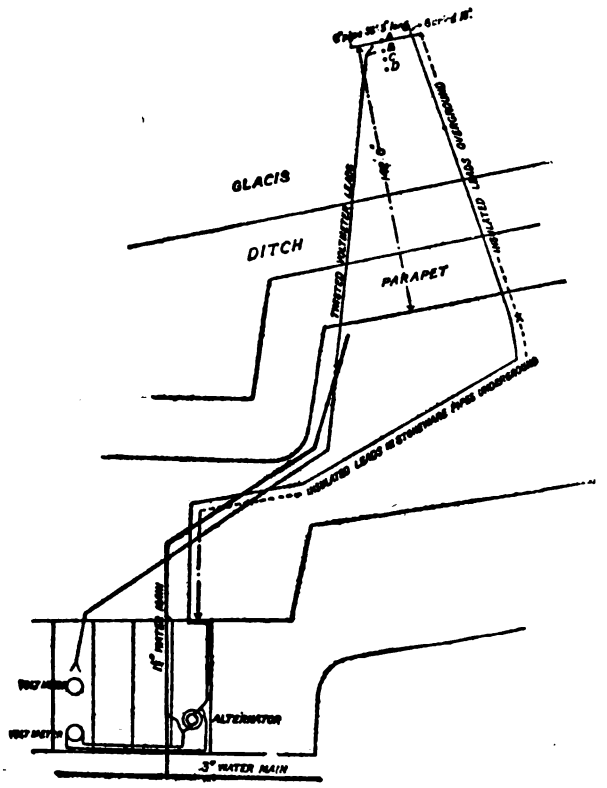

FIG. 2.

TABLE II.—Experiment of March 16, 1894.

Readings on statical voltmeter on terminals of alternator.	Readings across weights.		Remarks.
	On Cardew voltmeter.	On statical voltmeter.	
	Weights A and B.		
340	—	105	Weights, each 1/56lb.
425	—	130	Frequency about 80.
440	—	140	Weights 4ft. 5in. apart
408	28	—	from centre to centre
445	29·5	—	in a line at right
485	33	—	angles to pipe, and
515	36	—	about the centre of
550	37·5	—	its length.
590	42	—	
610	43	—	
620	43·5	—	
	Weights B and C.		
575	—	102	Pipe buried to same
590	—	106	depth as in first
600	—	108	experiment.
610	—	110	Soil rather dry.
610	38·5	—	
	Weights C and D.		
610	—	15	—
	Weights B and D.		
610	37·5	—	—
610	—	135	
	Weights A and C.		
505	55	—	Potential difference too
520	55·5	—	large for statical
550	56	—	voltmeter.
590	60	—	
600	60·5	—	
610	60·75	—	
	Weights A and D.		
550	64	—	Potential difference too
570	66	—	large for statical
600	70	—	voltmeter.
610	70·75	—	
620	71·5	—	
620	73	—	

An interesting note made on this experiment is as follows: "The soil in which the pipe was buried was loamy, and when digging the trench no worms were noticed, but towards the conclusion of the experiment it was observed that hundreds of worms came to the surface between 3ft. and 9ft. on either side of the pipe; no worms appeared, however, immediately over the pipe." The ground was much drier than was the case in the first experiment, and, probably in consequence of this, it appears that while the statical potential difference between the two first weights is relatively greater in the second than in the first experiment, the potential difference obtained with a current-using instrument is relatively less.

By interpolating an approximate value for the fall of potential between A and B from the readings obtained on the Cardew voltmeter, a rough curve of the fall of potential on the surface of the ground, for a charging pressure of 610 volts is obtained, as shown in Fig. 3, Curve *a*, the height of the curve above absolute zero being made consistent with the evident approach of the curve to its asymptote at D. In this case, therefore, the effect of the leakage extended to a distance of about 14ft. from the pipe, and the fall of potential on the surface appears to have been most rapid at a distance from the line immediately above the pipe equal to twice the depth at which it was buried.

A third experiment was carried out on May 22, 1894, with the same arrangements as in the second experiment. The objects for which this was undertaken were chiefly to obtain a record of the variation of potential difference on the surface with the charging current, which had not been previously recorded, to obtain results from charging with continuous as well as alternating current, and to extend the investigation as regards the latter. Unfortunately, the continuous-current generator could not be used, owing to a mechanical defect which could not be removed in the limited time available. Still, the results obtained with

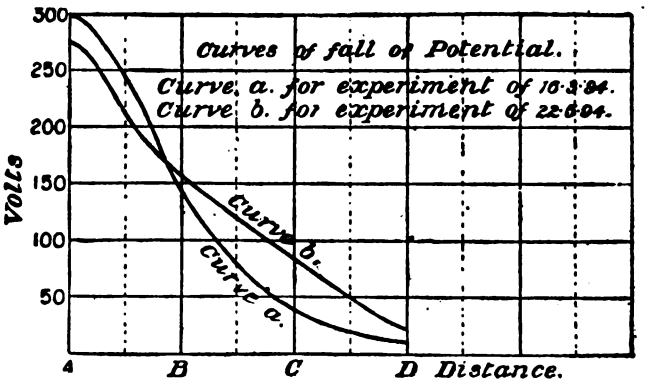

FIG. 3.

alternating current are, it is considered, of some value, especially as the condition of the ground was different from that which existed at the time of either of the two former experiments, it being wet on the surface with rain falling during a portion of the time, and dry underneath. Curve *b* in Fig. 3 appears to show by its form the effect of this state of the soil, the fall of potential from B to D being approximately indicated by a straight line—that is to say, that the current flow was practically entirely confined to the surface layer. The curve is deduced from the results of experiments shown in Table III. for a charging pressure of 550 volts.

TABLE III.—Experiment of May 22, 1894.

No.	At machine.			Reading across weights.		Remarks.
	Volts.	Current.	Exciting current.	On Cardew voltmeter.	On statical voltmeter.	
				Weights A and B.		
1	300	13·3	—	—	65	Weather wet
2	345	15·17	—	—	75	after dry. Wet
4	370	16 4	—	—	80½	surface, dry
6	387	17	—	—	84½	underneath.
9	430	18·8	—	—	95	Weights, each,
10	500	21·7	—	—	107	1/56lb., and
11	550	24·35	—	—	122½	arranged as in
12	610	27·75	—	—	135	second experi-
13	625	28·8	—	—	142	ment.
				Weights A and C.		Pipe buried to
14	470	21·79	—	40	—	same depth.
15	505	22·1	—	43½	—	
16	550	25·53	—	47	—	
17	565	26·7	—	50	—	
18	610	28 6	—	56	—	
19	625	29	—	59	—	
				Weights A and D.		
20	495	23·11	12	55	—	
21	530	24·3	13·5	59½	—	
22	555	25·53	14·25	63½	—	
23	580	26·4	15·75	67½	—	
24	—	21·79	12	—	225	
25	—	24·35	13 5	—	245	
26	—	25·3	14·25	—	255	
27	—	26·4	15·75	—	262	

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In order to obtain a direct indication of the statical potential difference between weights A and B, the voltmeter which had been used for recording the charging pressure was connected to these points and observations taken, when the exciting current for the field magnets of the dynamo and the charging current to the pipe were practically the same as in a previous set of experiments, for which the charging volts were known. Both sets of experiments are shown in the table. The disturbance of the worms was again very distinct, and they appeared on reaching the surface to set their bodies parallel to the pipe or along an equipotential line.

The experiments as a whole show conclusively that under very different conditions of weather and amount of moisture in the soil it is possible to produce a fall of potential amounting to 25 per cent. of the whole pressure in the supply between points on the surface of the ground 4ft. apart, a distance which most horses stand over, and, further, that although the connection of such points by a conducting body naturally reduces this potential difference, yet when this conductor has about the resistance of a horse (say, 400 ohms), sufficient current will pass to give a severe shock. It is hoped that when opportunity serves these experiments may be extended to the case of pipes buried to greater depths, and to observe whether any difference is produced by the use of a steady in place of an alternating pressure.

APPENDIX II.

Extracts from the Regulations for Securing the Safety of the Public, etc., made by the Board of Trade under the Provisions of the Electric Lighting Acts, 1882 and 1888, and of the City of London Electric Lighting Orders, 1890 and 1891.

(7) Where any high-pressure conductor is laid in a subway, or in the same conduit with any low-pressure conductor, it shall be completely enclosed in strong metal casing efficiently connected to earth.

(8) Where any high-pressure conductor is laid within a less distance than 18in. from any low-pressure conducter or from the surface of the ground, or where any low-pressure conductor is laid within the above-mentioned distance from any previously-laid high-pressure conductor, efficient means shall be taken to render it impossible that the low-pressure conductor or the surface of the ground shall become electrically charged by any leakage from or defect in the high-pressure conductor.

(14) Every conduit for conductors constructed in streets in which gas-mains are also laid shall be efficiently protected against an accumulation of gas.

(15) Where a street box contains any high-pressure conductor, efficient means shall be taken to render it impossible that the cover or other exposed parts of the box, or any adjacent material forming the surface of the street, shall become electrically charged, whether by reason of leakage, defect, or otherwise; and every street box shall be efficiently protected against any accumulation of gas or water, and its cover so secured that it cannot be opened except by means of a special appliance.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 21.

PROF. GEORGE FORBES in the chair.

The **Chairman** stated that Mr. Crompton was unable to be present, in consequence of having been summoned to the Continent. Without calling upon the secretary to read the minutes of the previous meeting, he asked Dr. Hopkinson to read his paper (of which we give an abstract) on

Propagation of Magnetisation in Iron.

BY J. HOPKINSON, F.R.S., PAST-PRESIDENT, AND E. WILSON, MEMBER.

The paper deals with the same subject as was dealt with by the same authors at a meeting of the Royal Society on May 31, 1894, but the experimental work is carried out with larger apparatus. It has, of course, been long known that in electro-magnets with solid cores currents are induced in the solid iron when the magnetising current is reversed, and that these currents for a certain time retard the development of changes in induction. The length of time that these currents exist will be surprising to many. In the experiments shown, a magnet of 12in. diameter was used, and exploring coils are buried in its substance. These show how the change in induction occurs extremely rapidly near the surface of the magnet, less rapidly at some depths, and slowly at its centre. With certain magnetising forces it takes as much as four minutes before the change at the centre of the core attains a maximum. The application of the results to magnets with cores of other sizes was pointed out, and conclusions were drawn as to the appropriateness of general practice in regard to the sizes of wires or plates used in transformers. The experiments were made in part with the reversals of current in the magnetising coils, and in part with the currents of a slow alternating character. The slow alternating currents were produced by means of a liquid reverser substantially similar to one which was described by Prof. Ewing.

DISCUSSION.

Dr. Fleming, who opened the discussion, said that it was with great delight they had seen the experiments given by one who was a master of the subject. He referred to some experiments made by the author and himself in 1882 at Messrs. Brotherhood's with different forms of dynamos. In one machine Dr. Hopkinson had abolished the multiple legs, and had substituted great oval legs. When that machine was tried it took ten minutes or a quarter of an hour to excite itself. He subsequently tried a Jumbo Edison machine. The field magnets were taken to Ponders End. On one occasion the cores were joined in series and current passed from a secondary battery to magnetise the field magnets, a galvanometer being inserted in series. Their astonishment was great to find that the current required six or seven seconds to become steady. The field magnets were 6in. or 7in. in diameter. Thus the figure practically agreed with that the author had mentioned. It was useless to employ solid conductors over a certain diameter for alternating currents, and hence Mr. Ferranti had adopted tubes for the Deptford mains to London.

Captain Creak, who referred to the electric lighting of war vessels, stated that they had a number of ships in which there was a pair of dynamos placed symmetrically one on either side of the compass. The consequence was that if they ran the port dynamo at night, and the starboard remained idle, they would have a change of some 4deg. in the course, or, at 19 knots, about 150 miles in the result. But by using the starboard dynamo as a corrector that was absolute.

Mr. W. H. Mordey was glad to find that the kind of lamination adopted in transformers had been confirmed by the researches brought before them. An important point touched upon was the excitation of a solid core by a redressed current. He had designed large alternators with large solid cores, the magnets of which were excited by redressed alternating currents. To his surprise he found that it required the same current to excite them, and that the watts taken were very little higher than with the direct current. The power factor was ·7, and there was no marked absorption of power. Apparently with the redressed current the magnet settled down to some steady condition, and there was very small surface fluctuation. That was the kind of explanation that occurred to him at the time. Could the author throw any light on the matter. The speaker then referred to some experiments made by Prof. Hughes.

Mr. Evershed discussed the question of the penetration of induction to the core, and the use made of mathematics in relation to the subject.

Mr. G. L. Addenbrooke considered that the author's experiments bore an important point in regard to the design of alternators. The self-induction between the armature and the magnet depended upon the permeability of the magnet. It was evident whether they had a large and massive field in the alternator that the self-induction could not rise to the amount that they would anticipate in the ordinary way, and that, therefore, the reaction of the armature on the field magnets could not be so great as would otherwise be expected.

Prof. G. Forbes, who regarded the subject as one of the greatest difficulty to attack, referred to the Gaulard and Gibbs patent case, and to the statement made on that occasion by Lord Kelvin that the difference between a laminated core and a solid one was known. He did not know whether Lord Kelvin went into mathematical calculculation and applied it. Dr. Hopkinson, however, left out the mathematical calculation, and tackled the subject by experiments. He thought that the striking part of the experiments was the way in which No. 1 coil did not move under the influence of changes in the induced currents surrounding it, until the effect of the induced currents of No. 2 had ceased. With regard to Captain Creak's remarks, why did not the Admiralty adopt ironclad dynamos, and the difficulty of affecting the compass would be overcome.

Dr. Hopkinson, in the course of his reply to the discussion, stated that the galvanometers used at the meeting were of the Ayrton and Mather type, made by Mr. Paul. He paid a tribute to the assistance rendered by Mr. Wilson; in fact, the latter had done much original work. He was also indebted to some of the student demonstrators from King's College, Messrs. Cobb, Evans, and Mokofsky.

Votes of thanks were passed to the authors, to the Council of the Society of Arts, and to Sir Henry Trueman Wood and his staff. The next meeting of the Institution was announced for Thursday of next week.

Temporary Lighting of Vessels.—Some time ago we referred to the steps taken by an electrical firm to induce the owners of the vessels patronising the Manchester Ship Canal to avail themselves of portable electric lighting plant for making night passages through the canal. We now note that the Compagnie Nationale d'Electricité, of Caen, are about to follow this example in regard to the lighting of vessels passing from Caen to the seaboard. The company will undertake at their own risk the electric lighting of the vessels on payment of an annual subsidy of £24 for at least five years, and a certain charge per ship. The charge, which will include the provision of five portable batteries and a projector of 200 c.p., will be as follows:

For vessels up to 600 tons	£1	8	0
,, from 600 to 800 tons	1	12	0
,, ,, 800 to 1,000 tons	1	16	0
,, of and above 1,000 tons	2	0	0

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SUBMARINE CABLES IN WAR TIME.

Lieutenant-Colonel H. Elsdale, R.E., contributes an article to the current *Nineteenth Century* on the question, "Should we hold on to the Mediterranean in War?" The author comes to the conclusion that we ought to abandon the Mediterranean, but he puts the points against such an act very fairly, and, among other things, he says:

"It is, perhaps, of greater importance that by losing Egypt we shall lose our telegraph lines to the East, which pass through the Isthmus of Suez. This is undoubtedly a serious matter. *The evil will, however, be minimised by the lines round the Cape and across Canada.* [The italics throughout this quotation are ours.] In any case, and apart from the present question, it is of the *first importance that we should secure continuous submarine communication* with all our leading stations abroad, with no such weak links as that at the Isthmus. This is undoubtedly a pressing matter, whatever be our precise strategy in war."

The holding of the Mediterranean at all cost has probably been the foremost idea of most Englishmen who have hitherto studied the question, but Colonel Elsdale makes out a very good case. To an ordinary mind, the loss of command of the Suez Canal and through the Mediterranean means danger to India and our Eastern possessions. The author we have quoted, on the contrary, holds the abandonment of the Mediterranean means safety to our Eastern possessions, an overwhelming preponderance of force in our favour, and danger to the enemies' colonies. However this may be, the one question with which we have to deal is that pertaining to cables. Our readers know that the policy we have always advocated is in this matter that a Pacific cable ought to be laid, touching no possibly hostile territory, and going throughout through English possessions. We even would go so far as to have the cable direct from England to Canada, and not from Ireland to Canada. Under the conditions laid down by Colonel Elsdale, at the present moment we have absolutely no safe way of telegraphically communicating with the East. Every cable has ends somewhere or other on what would be hostile territory. He is in error when thinking, as he seems to think, that we have an alternative way to the Cape by the West Coast route. This cable is a succession of links—some of the ends of the links, as we say, touching hostile territory. The Indo-European, or overland, route will not help us at all, as this goes through what might be an enemy's country. The policy of the late Sir James Anderson—for he was really the originator and brainworker of the two—and Sir John Pender—who is not and never has been more than the spokesman—was to have the cable in sections, as conducing more to tap commercial centres, than in direct routes. We have no objection to this policy, and would admit, from a commercial standpoint only, it is probably the best way of making cables pay. From an Imperial point of view, however, we doubt if the policy is correct. We have often heard the argument for what we may term the loop system in war. The line may be easily cut, but it also can be easily repaired.

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There would be little difficulty in laying a duplicate cable, cutting out any loop that touched upon hostile territory. That is quite true, and there is much to be said in favour of this plan; but there is also one great and overwhelming objection to it: these duplicate loops are not laid, and never will be laid, by private individuals seeking a return for capital expended. The question then resolves itself into this, Will the Government lay the necessary loops purely for Imperial purposes? They are not wanted commercially, so there would be no return for the capital expended. Or, will the Government, in conjunction with the colonies, lay a Pacific cable which should be both effective for Imperial purposes and at the same time have a greater or less commercial value? When we consider the value of cable communication for purely Imperial purposes, the same considerations as when thinking of trade do not arise. It is essential, when considering our colonial possessions, that in times of war we have, so to say, free speech with them without danger of any adversary knowing what is being said and done. Wars cannot be carried on nowadays as they were in olden times, when years might be spent in preparation, as well as years in conflict. Modern wars promise to be short and sharp. A few months, and a nation is lost or saved. To England, it would seem, then, of vital importance not to shilly-shally over questions of such vital importance in the inane meanderings which now constitute the bulk of parliamentary work. It is very well to say that at the commencement of all her great wars this country was found unprepared, but that she made gigantic efforts during the progress of the wars, and finally came out victorious. All that has changed, and, as said before, it is very doubtful if time will be obtained during the next war to make defects good and to do work which ought to be done during the piping times of peace. From the estimates sent in, we have seen that the Pacific cable can be laid for considerably less than was at one time supposed, and it only requires the co-operation of our Government with colonial efforts to have that cable complete and in working order by the end of 1896. From the importance of the matter, and from the information given in Mr. Sandford Fleming's memorandum, it would seem that the commissioners representing the parties interested need not take long to come to a final understanding on the whole matter.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WATER-POWER INSTALLATIONS FOR ELECTRIC LIGHTING.

SIR,—Referring to the contribution in your last week's issue by Mr. E. R. Dolby upon "Water-Power Installations for Electric Lighting," although we fully agree with that gentleman that water-power schemes are frequently delusive (and we speak feelingly, for much of our time has been wasted in explaining that ½ h.p. will not light a large house), yet we think that the paragraph you were good enough to insert in the same issue upon "Electric Locomotives in Mines" provides another side to the question, as the whole of the pumping, hauling, lighting, winding, etc., in the mine referred to is performed entirely by water power—about 100 h.p. in all.

We are induced to write this as we think that Mr. Dolby's remarks may be interpreted (or rather misinterpreted) to condemn the use of water power in this climate.

Yours, etc.,

THE ACME AND IMMISCH ELECTRIC WORKS, LIMITED.
(H. Twelvetrees, Secretary.)

London, February 19, 1895.

REVIEWS.

Steelworks Analysis. By J. O ARNOLD, F.C.S., Professor of Metallurgy at the Sheffield Technical School. London: Whittaker and Co. Price 10s. 6d.

Those who have watched the enormous development in the steel industry during the latter half of this century will know how closely and continuously scientific investigation goes on at all large works. The Iron and Steel Institute is a noble monument to the untiring activity of those engaged in the industry, for the pages of its *Transactions* contain a mine of useful knowledge culled and contributed from the four quarters of the globe. Text-books, elaborate and otherwise, have been written, yet withal there is plenty of room for this work of Mr. Arnold's. This is not the place to discuss at any length the properties of steel that make it valuable, or the impurities likely to arise in the manufacture which may impair that value. The author commences by discussing the design and equipment of a works laboratory; then, in Section I., he plunges into the practical work, describing the constituents and possible impurities of steel, giving a clear and concise account of the various analytical processes worthy of notice, illustrating where necessary. So far as we can judge, extraordinary care has been taken throughout to ensure accuracy, and great pains have also been taken to make every process clear to the reader. The next section deals with the analysis of iron ores, and is as good as the preceding one. A section on refractory materials is followed by one on fuels—a most important branch of the subject. A section on sundry processes, principally dealing with slag, is followed by an appendix; and a fairly good index concludes a book which for clearness of exposition and general value to the steelworks chemist, and especially to the younger men, it would be difficult to surpass.

A Treatise on Industrial Photometry, with Special Application to Electric Lighting. By Prof. A. PALAZ, Sc.D. Translated from the French by George W. Patterson, jun., M.A., B.S., and Merib Rowley Patterson, B.A. New York: D. Van Nostrand Company. London: Sampson Low, Marston, and Co.

This is a long title to a good book—good in more than one way, in that it for the first time treats this subject exhaustively, and in that both method and subject-matter merit praise. The principles of photometry are first explained; the intensity and the various actions of light are then discussed. It would be almost possible to construct a good description of the subject by quoting some of the summarising and the defining paragraphs of the author. Here is an example:

"From a photometric point of view, the only radiations that are to be taken into account are those which are perceptible to the eye" (p. 9).

"The eye is then the standard piece of apparatus for all photometric operations: it is the photoscope required for every comparison of intensity of two luminous bodies—the eye here plays the same *rôle* as the galvanometer or the electrometer in electrical measurement by zero methods. We can therefore only tolerate for photometric measurements a healthy and well-formed visual organ. Furthermore, the obligatory employment of the eye imposes in photometric measurements a limit of precision determined by the sensibility" (p. 10).

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"The sensibility of the eye varies with the nature of the luminous rays" (p. 12).

"A body when heated sends forth rays—that is to say, it causes a vibratory movement of the ether, the nature of which depends on the temperature" (p. 14).

"The intensity of a source of light varies, in general, with the direction of the luminous rays. . . . If we lay off in various directions lines passing through the luminous source, whose lengths measure the intensity of the rays emitted in these directions, the *locus* of the points thus obtained forms a surface called the *photometric surface* of the source. In arc lights, for instance, the photometric surface may be considered, in general, as one of revolution about the common axis of the two carbons, although, in many cases, this condition is not perfectly fulfilled, on account of defects in the homogeneity of the carbons and in their centreing" (p. 17).

We could, as we say, construct a readable article of such quotations, but such is not our purpose. The author having discussed the principles of photometry, goes on to describe the various photometers that have been devised since the first used by Lambert in 1760, of that known as Rumford's, to the latest. These descriptions are full without being verbose, and, when necessary, illustrated. Then the question of photometric standards is discussed at considerable length, all the more important standards being described and compared. Of course, more careful attention and description is given of Violle's standard as adopted by the International Congress of Electricians in 1881. The resolution adopted by this congress is as follows:

"The unit of each simple light is the quantity of light of the same kind emitted normally by one square centimetre of surface of melted platinum at the temperature of solidification."

"The practical unit of white light is the quantity of light emitted normally from the same source" (p. 163).

Then follows a chapter on the general equipment of a photometric laboratory, after which is one of nearly 70 pages on photometry of electric light. Much of this information has at various times appeared in the technical papers, yet there is much information we should like to quote, but it would take up far too much space, and interested readers must obtain the book itself. No quotations will prove its value—only a careful study of the whole. The concluding chapter is also an important one—on the distribution and measurement of illumination—a branch of study most electricians are imperfectly acquainted with, being satisfied to work by rule-of-thumb. The translators have added a short appendix. Altogether, this work is exceedingly valuable for its completeness, simplicity of treatment, and mass of information collected. The translators have done their part of the work well.

NEXT WEEK'S NEWS TO-DAY.

The electric light in the Church of St. Peter, Eaton-square, W., is most unobtrusively placed, and is a great improvement, as it will help to preserve the exceptionally beautiful mosaics which cover the walls of the sanctuary, and which are such a feature of the church.

An amusing incident took place at the Royal United Service Institution on Wednesday afternoon when members of the Royal family were trying the telautograph. The Prince of Wales sent a message to the Duke of Connaught at the other end of the building. The Duke smartly replied in a firm, bold hand, "When you next write to me please make your handwriting a little more distinct." The Prince roared with laughter. His handwriting was probably affected by his cold.

M. Emile Gautier, the well-known *savant* who has for many years contributed articles on scientific subjects to the *Figaro*, has just placed himself at the head of a literary undertaking to which everyone must wish success. It is a weekly periodical for popularising science, entitled *Science Française*. Among the contributors will be Prof. Chantemesse, Inspector-General of the Sanitary Services; Prince Roland Bonaparte; M. Germain Bapst; M. Maurice Leblanc, the well-known electrician; Sir John Lubbock; M. Bonvalot, the explorer; and M. Janssen, of the French Institute.

So we are to have mica from Canada. Mr. Harrison S. Watson, of the Canadian Section of the Imperial Institute, Imperial Institute-road, Kensington, S.W., informs us that Dr. G. M. Dawson, the director of the Geological Survey of Canada, has sent him a collection of some 50 samples of Canadian mica. The export of this article from Canada to the United States for electrical purposes has steadily increased, and Dr. Dawson has requested Mr. Watson to call the attention of English electrical manufacturers and others to the qualities of the Canadian mica with a view to its further introduction into British markets. The samples of mica are on view in the Canadian Section at the Imperial Institute, where they may be inspected between the hours of 10 a.m. and 4 p.m.

BLACKBURN ELECTRICITY WORKS.

The formal opening of the electricity works at Blackburn, which we described in our last issue, was performed on Monday by the Mayor (Alderman R. T. Eastwood), in the absence, through illness, of Alderman W. Thompson, the chairman of the Gas Committee. The Mayor was accompanied by most of the members and principal officials of the Corporation, and there were also present representatives of the consulting engineers and contractors engaged in carrying out the works, including Mr. A. S. Giles (the recently-appointed resident electrical engineer) and Mr. Alex. Siemens (principal of Messrs. Siemens Bros. and Co., Limited). The company first assembled in the building where the dynamos and engines are located. The formal proceedings commenced by the Mayor asking the engineer to start the engines, and this having been done, his Worship switched on the current and declared the installation complete, hoping it would prove the great success which the Gas Committee and Corporation anticipated. The company then adjourned to luncheon in an upper room of the building.

The MAYOR, in rising to propose "Success to the Blackburn Electric Lighting Installation," deeply regretted the absence of Alderman Thompson, and remarked on the pleasure it would have given all present to hear the worthy chairman give some facts and figures with regard to a work in which he had taken such increasing interest. It might be that he (the speaker) was somewhat of a pessimist, but he could hardly think that at present, at all events, the Corporation would make more than the interest on the money they had laid out on the electric lighting plant, not to name a profit at all; but he hoped there would be such a healthy competition and rivalry for the new illuminant amongst the tradesmen of the town that the works would soon be a paying concern. The Corporation had expended up to the present time between £17,000 and £18,000. They had sanction to spend £32,000, but they intended to keep well within that limit after they had extended the plant sufficiently to meet the requirements of everybody in the extended area. After complimenting the contractors on the manner in which the various works had been carried out, the Mayor expressed the hope that the consumption of gas would increase along with the use of electricity, and he stated that close upon 3,000 of the 10,000 lights which the works at present are calculated to supply were already applied for, and before the end of this year he hoped from half to three-fourths of the total number would be connected.

Mr. ALEX. SIEMENS responded, and gave some details of the Blackburn installation. He congratulated them on having adopted direct driving and the low-pressure three-wire system. Speaking as one to whom it did not matter whether he fitted up gas or electricity works, he could give them the best appliances for either; he could safely predict a great success for the installation, and said he did not see any reason why the Corporation should not soon be receiving 7 per cent. on their outlay, as was the case in Bradford.

Councillor HAMER, in proposing the health of the chairman of the Gas Committee, paid an excellent tribute to the capabilities of Alderman Thompson, not only as regarded the work they had just seen brought to an issue, but with regard to everything he undertook, and remarked that those who opposed could but respect him, for he never deceived anyone by a trick of language.

Alderman T. E. THOMPSON responded on behalf of his uncle, and reciprocated the kindly feeling and the good wishes.

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Alderman RUTHERFORD submitted the toast of "The Mayor and Corporation of Blackburn" in an effective speech. He complimented his Worship on the able manner in which he had presided over the town's affairs since his election. The Corporation deserved well of the public, seeing that they had carried out so many important works without raising the rates above the average of those in other large industrial towns.

His WORSHIP, in responding, remarked upon the pleasantness of mayoral duties with such willing and considerate townsmen to make them light.

Councillor KENYON also responded on behalf of the Corporation, and other toasts brought the proceedings to a close.

THE PACIFIC CABLE QUESTION.

An important memorandum by Mr. Sandford Fleming respecting the establishment of the Pacific cable has been made public in Canada. It gives information up to date of the progress made with the scheme since the meeting of the Ottawa Conference, and states what are understood to be the accepted views of the Canadian Government.

Acting under the resolution of the conference, which requested that the Canadian Government should take the necessary steps to promote the construction of the cable, the Dominion Government called for tenders under three forms. By the first of these, Form A, the cable is to be owned and controlled by Government, to be worked under Government authority, and to be kept in repair by the contractor for three years. The only actual offers received are, Mr. Sandford Fleming informs us, according to this form, and he proceeds to state that: "Among the tenders received is an offer from an old-established and reliable firm to lay the cable on route No. 1—the all-British route by Fanning Island—for the sum of £1,517,000. This price includes maintenance and repairs for three years after the whole line shall have been completed and put in operation; consequently, there would be no disbursement for these services during this period to be met by the earnings of the telegraph. The cost of working and interest on capital would be the only charges against revenue during the first three years after the cable shall have been laid."

By this offer it is made clear that the assent of the Hawaiian Government to the proposal of Great Britain to lease Neckar or Bird Island for the purposes of a telegraph station is not considered by cable manufacturers as by any means necessary to the successful laying of an inexpensive line of cable communication across the Pacific.

Mr. Sandford Fleming is strongly in favour of the principle of State ownership of the cable. On this subject, after referring to former occasions on which he has maintained that it would be unwise to subsidise a company when the object in view can more economically and with greater advantage to the public be attained by other means, he says: "It has since been suggested as an alternative to a subsidised company (Form B) to establish a company under a Government traffic guarantee (Form C). That is to say, the company to be guaranteed a gross revenue from traffic for a term of years; the deficiency between actual earnings and the guaranteed earnings to be made good by the Governments each year. To my mind, this plan is scarcely less objectionable than the first-mentioned. Let us, by way of illustration, assume that a company is formed under a Government guarantee of gross traffic equal to £200,000 per annum for a period of 25 years. What, in this case, would prevent the existing company and the new company entering into a secret pooling agreement by which it would be the policy of both to pass over the old line the great mass of the traffic, the object being to establish against the Governments each year of the 25 as large a claim as possible under the guarantee? I do not see that it would be possible to prevent the two companies amalgamating their interests in this or in some other way; and, as a consequence, a powerful monopoly would be built up to exact its own terms. Looking at the subject in all its bearing, the true plan, in my judgment, is to make the Pacific cable a public undertaking from its first construction. I am satisfied the more the subject is considered, it must become clear that only by the observance of the principle of State ownership will the greatest public advantage be permanently obtained. If, in establishing the Pacific cable as a public undertaking, the co-operation of the mother country with Canada and the Australasian colonies be secured, the most advantageous consequences will undoubtedly proceed from this arrangement. The first effect of co-operation would be in connection with the initial cost of the work, as a joint guarantee would admit of the required capital being raised at the lowest possible rate of interest."

Assuming the principle of co-operation and State ownership to be assented to, Mr. Sandford Fleming calculates the cost of the undertaking as follows: "Should the most costly of the several routes which have been spoken of be adopted—that is to say, the route by Fanning Island, with branches to New Zealand as well as Australia—I am unable to see with this tender before us, offering to complete it in every respect for £1,517,000, that the capital to be raised need exceed £1,600,000. This capital raised at 2½ per cent. gives £40,000 as the total interest to be met yearly. As it is advisable in forming an estimate of this kind to make full and complete provision for unforeseen contingencies of whatever kind, 10 or 12 per cent. may be added. In this view £45,000 may be considered the maximum interest charge, to which, if we add £30,000 for working expenses, we have the sum of £75,000 as the total fixed charges to be met by revenue in each of the three years after the cable shall have been opened for business."

This brings Mr. Fleming to the consideration of the question of probable revenue. On this point various documents are appended to the memorandum, amongst others, a statement drawn up by the Dominion statistician, Mr. George Johnson, showing the increase in Australasian telegraph business with Europe in the last 20 years to have been from 235 160 words per annum to 1,401,293 words per annum. Allowing for some continued increase, and for what is considered a fair division of the business with existing lines, it is estimated that the gross earnings at 2s. a word during the first three years of the operation of the cable would, as a consequence of the agreement with the contractor to maintain the cable in working order for that period, give a surplus of revenue over expenditure of £154,000 for the three years. After the third year the cost of maintaining the cable would be a charge against surplus earnings. Mr. Sandford Fleming states the position as follows: "The following table covers the remaining seven of the first 10 years after the opening of the telegraph for traffic, and is computed on the principles set forth in the appended papers. The cost of repairs and maintenance, usually estimated at £6 per mile, would amount to £43,000 per annum. For this service I have allowed £50,000, which, added to interest and working expenses, increases the charge against revenue to £125,000 per annum:

—	Gross earnings.	Charges.	Surplus.
Surplus for the first three years.....	—	—	£154,000
1901.....	£159,500	£125,000	34,500
1902.....	176,000	125,000	51,000
1903.....	192,500	125,000	67,500
1904.....	209,000	125,000	84,000
1905.....	225,500	125,000	100,500
1906.....	242,000	125,000	117,000
1907.....	258,500	125,000	133,500
Total surplus in 10 years.....			£742,000

Mr. Sandford Fleming is satisfied that his estimates are "reasonable and reliable." The first result of the Pacific cable from the mere reduction in rates alone will be, he claims, to effect a gross saving within a year after the cable shall be open of £190,000 in Australasia and the mother country.

The intention of his memorandum is briefly expressed in one of the concluding paragraphs. He says: "It has been my object to show by the facts I have presented and the figures I have produced that a mutual effort on the part of Great Britain and the two great divisions of the Colonial Empire can establish the Pacific cable with ease and practically without cost to the taxpayer in either country."

The memorandum has been communicated to the Imperial and Australasian Governments, and it is proposed that a joint commission composed of an Imperial, a Canadian, and an Australasian representative should meet in London to discuss financial and other details. The answer of the Australasian Governments to this proposal has not yet been received.—*The Times.*

THE "GLENBOIG" STREET BOX.

The recent explosions of gas in connection with underground mains should cause special attention to be paid to any methods designed with a view to overcome this difficulty. Among these may be mentioned the stoneware street boxes brought out by the Glenboig Union Fireclay Company, Limited, of 4, West Regent-street, Glasgow. The type of box illustrated in Fig. 1 is made in one piece, and is glazed both on the inside and outside. This box is arranged for both iron pipes and troughs, and is claimed to be both gas and water tight. The conductors and leading-in ways are packed at the entrance to the box with yarn, whilst the iron cover is set in red lead. The box, which is made in various forms and sizes so as to meet any requirements, has been approved by many electrical engineers. In our second illustration is given a section of a transformer-box, also made of stoneware. It will be seen that a stoneware support perforated so

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as to allow the insulating oil to enter is provided for the accommodation of the transformer, the conductors entering the box

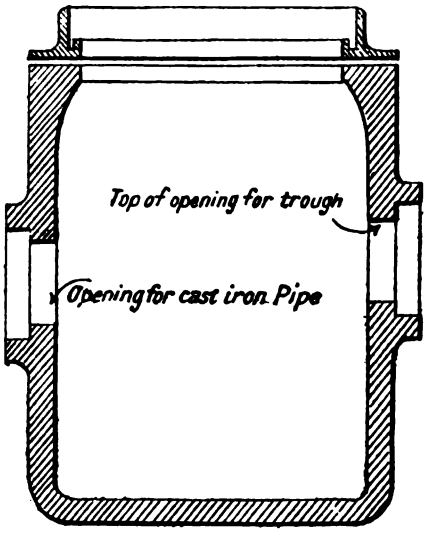


Fig. .—" le boig " Stre Box.

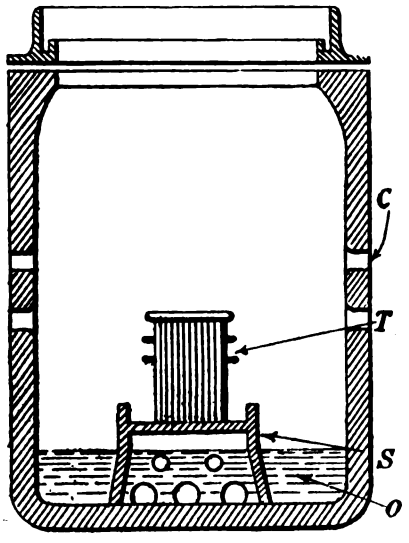


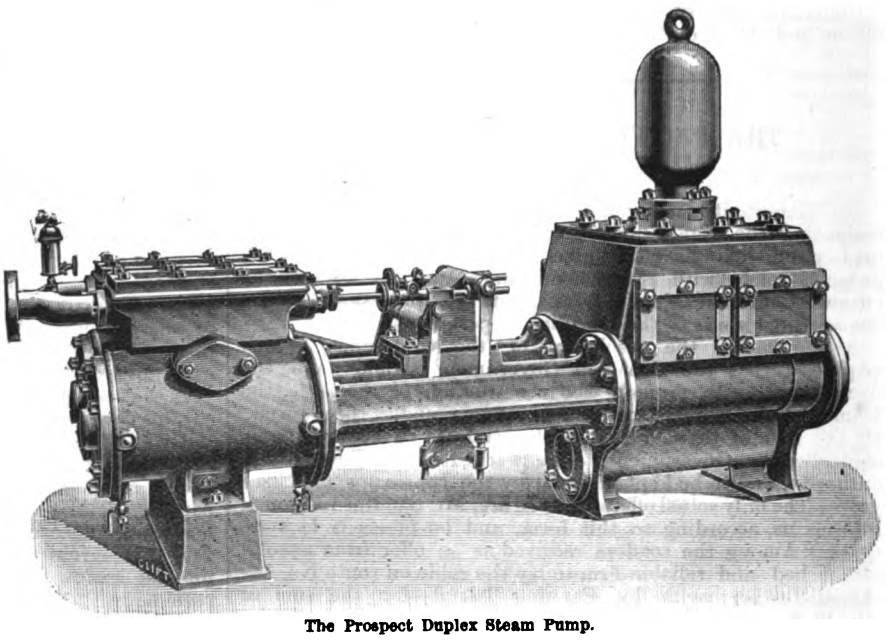
FIG. 2.—" Glenboig " Transformer Box.

being packed, as shown in Fig. 2. C shows where the conductors are brought in, T represents the transformer, S the support, and O the oil.

THE PROSPECT DUPLEX STEAM-PUMP.

In a recent issue reference was made to the duplex steam-pump made by Messrs. Cole, Marchent, and Morley, of Bradford, and we are now enabled to give an illustration of it. It is claimed that this pump, which has been devised by Messrs. Holehouse and Morley, is the only direct-acting pump which can use the steam expansively and make regular strokes. The great feature of this pump is that the steam in each cylinder is distributed in each cylinder by means of a double or compound motion, each side having part control of its own and its neighbour's valve, and with a rigid connection to the valve this will enable the pump to be worked expansively according to the relative proportion of the levers. A suitable proportion has been arrived at for general work, and to enable the engine to be easily started and run slowly, the hand wheels, shown on the valve spindles of the illustration, are provided to give adjustment to the expansion from about seven-twelfths to full length of the stroke, which adjustment can be made and easily seen by an outside indication whilst the engine is in motion. This simple alteration to the old duplex action, the makers state, gives more advantages than may appear at a first consideration. The compound action causes the pumps to run nearly as though they were coupled to cranks at right angles, and they only pause to allow of reversing the stroke. Consequently, as both pumps are always in motion, this pump at the same speed will, it is claimed, lift twice what is lifted by the ordinary duplex pump, for the ordinary duplex pump wastes half its time with the pause at each end of the stroke.

The steam also is stopped entering the cylinder before, or directly it has got to, the end of its stroke, this effecting a saving of steam. By the same reason the compression is arranged for by the valve at the proper time, and can be adjusted by the wheels before referred to so as to suit the speed, pressure, or waterhead, and as the valve adjusts its own lead and compression there will be no short strokes, which is again a saving of steam. Messrs. Cole, Marchent, and Morley state that only at starting a pump arranged for a heavy head, without any head on the pump, is any bumping of the covers likely to occur, and that this is prevented by the addition of a compression port. When the pump is once started the delivery



The Prospect Duplex Steam Pump.

main may break, but the pump is very unlikely to bump the covers. If the arrangements are such that the pump can be worked expansively, it is impossible to bump the covers under any conditions. This type of pump, for which a large capacity, high efficiency, and saving of steam are claimed, is suitable for a variety of purposes, including the feeding of boilers, and as condenser pumps, etc.

LEGAL INTELLIGENCE.

GLYN v. PLANET ELECTRICAL ENGINEERING COMPANY.

In the Westminster County Court on Friday his Honour Judge Lumley Smith, Q.C., had before him the case of Glyn *v.* the Planet Electrical Engineering Company, in which the plaintiff sought to recover commission at the rate of 7½ per cent. on certain orders for electric light work obtained by him on behalf of the defendant company.

It appeared from the evidence of the plaintiff that he was formerly in the employ of the company as traveller, at a salary of £2 a week and 5 per cent. commission on the orders which he succeeded in bringing in, but some time ago the arrangement was put an end to, and it was agreed that he should have 7½ per cent. commission in lieu of salary. Upon that understanding he obtained several orders for the defendants, but when he made his claim for commission they declined tc allow him more than 5 per cent., which sum he refused to take, and then this action was commenced.

For the defence, it was absolutely denied that there ever was any arrangement made to pay the plaintiff 7½ per cent., or that he had ever been paid more than 5 per cent. It was further contended that the plaintiff was not entitled to be paid his commission until the defendant company received payment for the work, but, in spite of that, he had included some items in the present claim in respect of work which had not yet been paid for. The amount which the defendants admitted to be due to the plaintiff on the 5 per cent. basis was £3. 9s., and that sum had been paid into court as being the amount due up to the date of paying in.

His **Honour**, after hearing the evidence of the defendants' witnesses, said he was satisfied that the amount paid into court was sufficient, and gave judgment for the defendants, but without costs.

COMPANIES' MEETINGS AND REPORTS.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Alfred Sohier Bolton, Esq.; Sir Frederick J. Bramwell, Bart, F.R S.; G. H. Hopkinson, Esq.; Granville R Ryder, Esq.; R. W. Wallace, Esq.

DIRECTORS' REPORT.

The directors submit to the shareholders a statement of the

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accounts of the Company, together with a report of the position of the undertaking at the end of the year 1894. The mains, which extended to a length of 16½ miles on December 31, 1893, have been increased during the year 1894 to 18¾ miles. The price of electricity to consumers has been reduced 25 per cent.—viz., from 8d. to 6d. per Board of Trade unit—throughout the district, such reduction having taken effect from July 1 last. During the year the number of houses and shops connected with the system has increased from 734 on December 31, 1893, to 908 on December 31, 1894; while the number of lamps calculated on the usual basis of 8 c.p. has increased from 64,529 to 80,678. The directors have thought it advisable, in view of the increased profits of the Company, to use a large portion of that increase in writing off the balances of the preliminary expenses, and cost of debenture issue account (£500), and of the suspense account (law—£1,199). They also have thought it advisable to strengthen the renewal account by transferring to that account £3,457. 5s. 9d. After providing for the above amounts, and paying the dividends on the 6 per cent. first preference shares to June 30, 1894, on the 5 per cent. second preference shares to September 30, 1894, and an interim dividend at the rate of 5 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1894 is £4,235 14s. 10d. Of the above sum £1,450 has been appropriated to the payment of the first preference dividend to the end of the year, and £150 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date, leaving £2,635. 14s. 10d., out of which it is proposed to pay a further dividend on the ordinary shares at the rate of 5 per cent. per annum for the past half-year. This will leave a balance of £823. 4s. 10d. No provision has been made in the accounts for directors' remuneration. In accordance with the articles of association, Sir Frederick J. Bramwell, Bart., F.R.S., and Mr. G. H. Hopkinson retire from the directorship, and, being eligible, offer themselves for re-election. The auditors, Messrs. Lovelock, H. W. S. Whiffin, and Dickinson, offer themselves for re-election.

Dr. BALANCE-SHEET TO DEC. 31, 1894.	£	s.	d.
Capital—15,000 ordinary shares of £5 each	75,000	0	0
10,000 6 per cent. first preference shares of £5 each	50,000	0	0
2,460 5 per cent. second preference shares of £5 each	12,300	0	0
Mortgage debentures, 4½ per cent.	50,000	0	0
Sundry creditors and open accounts	3,764	6	0
Renewal account, balance at credit thereof	5,720	10	9
Net revenue account	4,235	14	10
	£201,020	11	7

Cr.		£	s.	d.
Plant, buildings, mains, furniture and fittings, provisional orders, goodwill, and South Kensington district, at cost		178,255	19	5
Freehold and leasehold property	£9,218 15 7			
Less sinking fund	535 0 3			
		8,683	15	4
Preliminary expenses and cost of debenture issue	500 0 0			
Less amount written off	500 0 0			
Sundry debtors		8,495	13	5
Stock-in-trade and stores		481	4	11
Consols		549	3	10
Cash at bankers	2 545 16 4			
Cash at bankers on deposit	2,000 0 0			
Cash in hand	8 18 4			
		4,554	14	8
Suspense account (law)	£1,199 0 0			
Less amount written off	1,199 0 0			
		£201,020	11	7

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1894.

Dr.	£	s.	d.
Manufacturing electricity, coal, oil, water, waste, sundries	5,140	18	9
Salaries	1,842	5	11
Miscellaneous expenses, including law charges	630	16	8
Rent, rates, and taxes	921	12	6
Insurance	119	18	6
Sinking fund, leasehold	103	0	0
Maintenance of buildings, mains, plant, meters, instruments, etc.	2,621	9	3
Repairs to leasehold property	20	2	0
Repairs to apparatus on consumer's premises	9	3	4
Incandescent lamps	56	14	11
Company's auditor	31	10	0
Board of Trade auditor	38	0	0
	£11,535	11	10
Amount written off preliminary expenses	500	0	0
Amount written off suspense account (law)	1,199	0	0
Renewal account in respect of buildings, mains, plant, batteries, and meters	3,457	5	9
	£5,156	5	9
Balance	9,289	1	9
	£25,980	19	4

Cr.	£	s.	d.
Sale of electricity (977,797)	28,143	9	8
Less rebates and bad debts	3,404	10	2
	24,738	19	6
Rent of meters	985	7	0
Sale and maintenance of lamps	65	2	10
Rent receivable	185	0	0
Transfer fees	6	10	0
	£25,980	19	4

Dr. NET REVENUE ACCOUNT.		£	s.	d.
Interest on temporary loans		7	18	11
,, ,, sinking fund		16	12	3
,, ,, deposits		0	10	6
Dividends on 5 per cent. second preference shares to Sept. 30, 1894	£357 9 9			
Dividends on 6 per cent. first preference shares to June 30, 1894	1,450 0 0			
Interim dividend at 5 per cent. per annum on ordinary shares to June 30, 1894	1,812 10 0			
Interest on debentures accrued to date, less income tax	2,086 10 2			
		5,706	9	11
Balance		4,235	14	10
		£9,967	6	5

Cr.	£	s.	d.	£	s.	d.
Balance from last account	4,788	7	9			
Less dividends to December 31, 1893—6 per cent. first preference shares, £1,456 5s.; Ordinary shares, £2,184 6s. 10d.; Directors' fees, £500 0s. 1d.	4,140	11	11			
				647	15	10
Interest				30	8	10
Balance from revenue account				9,289	1	9
				£9,967	6	5

Dr. RENEWAL ACCOUNT.	£	s.	d.
Balance	5 720	10	9
	£5,720	10	9

Cr.	£	s.	d.
Balance from last account	2,263	5	0
Amount brought from revenue account	3,457	5	9
	£5,720	10	9

Mr. A. Sohier Bolton, who presided at the meeting yesterday, moved the adoption of the reports and accounts. In doing so he stated that it was unfortunate that a life had been lost in connection with the Kensington Court station, but that it had nothing to do with electricity. Having referred to the number of lamps connected and the increase in the number of units supplied, the speaker said that this improvement had taken place notwithstanding the fact that the price per unit had been reduced from 8d. to 6d. He put the motion.

Mr. J. H. Hopkinson seconded the motion, which was adopted, and the proceedings terminated.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION, LIMITED.

Directors: G. H. Brougham Glasier, Esq., 7, St. James's-street, S.W. (chairman); Richard Chadwick, Esq., 34, St. Martin's-lane, W.C.; I. P. Mendoza, Esq., 4A, King-street, St. James's, S.W.; Agostino Gatti, Esq., Stefano Gatti, Esq., 436, Strand (managing directors). General manager and secretary: E. Wilmot Seale, Esq. Chief engineer: W. H. Patchell, A.M.I.C.E., M.I.E.E.

DIRECTORS' REPORT.

The directors beg to submit their annual report for 1894, with the accounts for the same period, duly certified by the Company's auditors. The directors have taken steps with a view to obtaining a provisional order for enabling the Company to supply electricity in the district of the Strand Board of Works in accordance with the resolutions arrived at in November last, but no portion of the capital authorised by these resolutions has yet been dealt with. The Corporation was on December 31, 1894, supplying energy to 41,216 8-c.p. lamps, an increase of 19·7 per cent. on the number supplied at the end of the year 1893. There are now upwards of 22 miles of mains laid, and the station has been maintained in all respects in a very high state of efficiency. As will be seen from the accounts, the directors have written £485. 0s. 3d. off preliminary expenses, and carried £1,600 to depreciation account. Provision for bad debts has been made by a deduction of £150 from the amount of sales of current in the manner required by the Board of Trade. The net earnings, as shown in the revenue account, have amounted to £10,395. 12s. 9d.; £3,117. 9s. 2d. has been paid in respect of interest on debentures up to December 31, 1894, and £2,906. 3s. 7d. was distributed in payment of an interim dividend for the half-year ended June 30, 1894. A sum of £3,929. 19s. 10d. now remains, which the directors propose to deal with as follows:

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Payment of a dividend of 4½ per cent. for the year 1894, less tax	£6,531 3 7	
Interim dividend paid August, 1894	2,906 3 7	
	3,625 0 0	
And to carry forward	304 19 10	
	£3,929 19 10	

Mr. G. H. Brougham Glasier and Mr. I. Percy Mendoza are the directors who retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. O. R. Johnson and Son, also retire and offer themselves for re election.

Capital Account for Year ending Dec. 31, 1894.

Dr.	£ s. d.
Purchase of generating station, mains, lands, buildings, and acquisition of rights, including law charges in connection therewith	122,777 4 10
Additional expenditure on buildings	17,531 9 3
Machinery	23,799 3 0
Accumulators at generating and distributing stations	977 2 10
Mains, including cost of laying the mains	38,177 9 9
Meters, and fees for certifying under the Act	2,641 8 4
Electrical instruments, connections, etc.	2,572 10 0
General stores (cable, mains, lamps)	—
Provisional order, etc.	262 4 8
Plant	952 4 10
Artesian well	1,854 10 9
Office furniture and tools	217 6 5
Total expenditure	£211,762 14 8
Balance of capital account	5,137 5 4
	£216,900 0 0

Cr.	£ s. d.
Ordinary shares of £5	150,000 0 0
Debentures, 5 per cent.	66,900 0 0
	£216,900 0 0

Note.—The remaining £3,100 of issue of £70,000 5 per cent. debentures have been applied for, and will be taken up as the circumstances of the Company require. No issue has yet been made either of debentures or shares authorised by the special resolution of October 23 and November 7, 1894.

Revenue Account for Year ending Dec. 31, 1894.

Dr.		£ s. d.
To Generation of Electricity.		
Coal or other fuel, including carriage, etc.	£4,806 6 3	
Oil, waste, water, and engine-room stores	611 11 0	
Proportion of salaries of engineers, superintendents, and officers	357 13 4	
Wages and gratuities at generating stations	1,603 2 11	
Repairs and maintenance as follows: buildings, £174. 16s.; engines, boilers, dynamos, motors, and other machinery, instruments, and tools, £1,470. 7s. 9d.; accumulators and accessories, £18. 6s. 8d.	1,663 10 5	
Clearing away ashes	112 5 6	
Lighting Company's own station	322 8 3	
		9,476 17 8
To Distribution of Electricity.		
Proportion of salaries of superintendents and officers	279 1 5	
Wages and gratuities to linesmen, fitters, labourers	262 1 10	
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	66 13 3	
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	63 17 10	
Wayleaves and licenses	39 15 0	
		711 9 4
To Royalties, etc.		
Royalties, etc., payable for use of patents or patent processes		25 0 0
To Rents, Rates, and Taxes.		
Rates and taxes		517 13 9
To Management Expenses.		
Directors' remuneration	84 0 0	
Salaries of managing engineers, secretary, accountants, clerks, and messengers	1,025 15 0	
Stationery and printing	94 14 9	
General establishment charges	129 14 7	
Auditors of Company	52 10 0	
Auditor appointed under the provisions of the order—two years, 1892 and 1893	91 9 2	
		1,477 3 6
To Law and Parliamentary Charges.		
Law expenses		231 2 5
To Depreciation.		
Depreciation in respect of leasehold premises, buildings, plant, machinery, etc.		1 600 0 0
To Special Charges.		
Insurances	75 10 0	
Stamp duties *re* debentures	10 16 0	
Expenses for certification of meters	10 15 0	
		97 1 0
Total expenditure		14,136 7 8
Balance carried to net revenue		10,395 12 9
		£24,532 0 5

Cr.	£ s. d.	£ s. d.
Sale of current per meter at 6d. (maximum) per B.T.U.	23,407 15 10	
Sale under contracts	114 0 0	
		23,521 15 10
Lighting own station and pumping water, charged *per contra*		462 1 6
Rentals of meters and other apparatus on consumers' premises	287 13 7	
Sale and repairs of lamps and other apparatus	70 10 8	
		358 4 3
Rents receivable, less outgoings, in respect of the Company's house property not in its own occupation	107 12 9	
Transfer fees	4 0 0	
Discounts, etc.	78 6 1	
		189 18 10
		£24,532 0 5

Net Revenue Account, Dec. 31, 1894.

Dr.	£ s. d.
Interest on debentures accrued due to date (less tax)	3,117 9 2
Preliminary expenses written off	485 0 3
Balance applicable to dividend on ordinary stock or shares	6,836 3 5
	£10,438 12 10

Cr.	£ s. d.
Balance from last year	43 0 1
Balance brought from revenue account	10,395 12 9
	£10,438 12 10

General Balance-sheet, Dec. 31, 1894.

Dr. Liabilities.	£ s. d.
Capital account	216,900 0 0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., to December 31, 1894	4,349 3 5
Sundry creditors for debenture interest to December 31, 1894	2,036 18 0
Net revenue account—balance at credit thereof £6,836 3 5; Less interim dividend paid thereout in August, 1894 2,906 3 7	3,929 19 10
Depreciation fund account	2,300 0 0
	£229,516 1 3

Cr. Assets.	£ s. d.
Capital account	211,762 14 8
Purchase of premises not used by the Company, including law charges in connection therewith	5,136 3 3
Stores on hand at December 31, 1894: coal, £78. 13s. 5d.; oils, waste, etc., £14. 12s.; general, £212. 17s. 5d.	306 2 10
Balance of preliminary expenses not yet written off	760 0 0
Sundry debtors for current supplied to December 31, 1894	7,676 16 7
Other debtors	46 5 0
Suspense account: law costs	956 12 0
Cash at bankers: Union Bank of London, Limited, and in course of collection, £2,927. 16s. 6d.; cash in hand, £3. 10s. 5d.	2,931 6 11
	£229,516 1 3

In moving the adoption of the report at the meeting yesterday, **Mr. G. H. B. Glasier**, who presided, said that he did not propose to go into figures, but on December 31 last they had 41,216 8-c.p. lamps installed, and 22 miles of mains were laid. Of course this required an outlay of capital, as the mains were laid, not for new lamps, but for probable demand. The past year had been satisfactory, because 2,721 lamps had been added, and the output had increased by 25·21 per cent. as compared with the corresponding period of last year. The directors had written off part of the preliminary expenses, and only £700 had to be dealt with. Last year £700 was placed to the depreciation fund, whereas £1,600 had been put to it this year, which equalled ½ per cent. on the entire share capital. The establishment of a reserve fund was wise, and provision had been made for bad debts. Last year the net earnings were £8,645, and this year £10,395, and this though the average price per unit was ¼d. a unit less than last year.

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The balance carried over last year was £43, and this year it was £304. The Chairman explained that they had worked their system economically as compared with other London companies, and they would do their best to carry out further economies. In their original prospectus they had said that 10 per cent. dividend could be paid on the shares, and that this might be increased. That statement was made on the authority of their auditor when the price per unit averaged 7¼d. The difference now amounted to £10,028. This equalled on the old basis a dividend of 11¼. The cause of the reduction in price per unit was due to competition. The action of the directors was justified by the Company being in a good position. They were taking steps to obtain a provisional order for a new district, and they would not issue the authorised debentures until this had been obtained.

Mr. Robertson seconded the motion and said that the management had been ably conducted. The price of coal seemed very high, and the Kensington Company obtained more per unit. He thought that their shares should stand higher on the Stock Exchange.

Mr. G. H. B. Glasier and Mr. I. P. Mendoza were re-elected directors, and Messrs. O. R. Johnson and Son as auditors.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

Directors: The Right Hon. Lord Suffield, K.C.B.; Edmund Boulnois, Esq., M.P.; W. Hayes Fisher, Esq., M.P.; Sir Douglas Galton, K.C.B., F.R.S.; J. Browne Martin, Esq.; James Heslop Powell, Esq.; R. W. Wallace, Esq. General manager: Captain Edmund I. Bax. Engineer-in-Chief: Prof. Alex. B. W. Kennedy, LL.D., F.R.S., M.I.C.E. Secretary: Frank Iago, Esq.

Directors' Report.

The Board of Directors, in presenting their report and the accounts for the year 1894, are pleased to state that the business of the Corporation continues to make satisfactory progress. The supply of current, which on December 31, 1893, was provided for the equivalent of 131,565 lamps of 8 c p, had increased by December 31, 1894, to the equivalent of 167,703, and at the present time there are on circuit the equivalent of 175,695 lamps of 8 c p, and applications have been received for a further 8,817. The length of roadway in which mains have been laid now exceeds 37 miles, making about 148 miles of ways, into which upwards of 115 miles of copper (strip and cable) have been drawn. The plant and machinery have been working satisfactorily throughout the year, and have been fully maintained from revenue. Your Board are also glad to be able to report that a still further reduction has been effected during the past year in the cost per unit, in generating, distributing, and general expenses. Owing to the continued increase in the business of the Corporation, it has been found necessary to provide further capital. In accordance with resolutions passed at extraordinary general meetings, held in October and November last, the share capital was increased from £300,000 to £400,000 by the creation of 20,000 new shares of £5 each, and of this amount £40,000 in 8,000 shares of £5 each has been issued to shareholders in accordance with the resolutions passed at subsequent extraordinary general meetings. In dealing with the revenue of the past year your directors have, after writing off bad debts, proportion of preliminary expenses, the whole of the patent and law charges account, and placing £2,500 to credit of depreciation, added a sum of £2,500 to the sinking fund. The net revenue of the year amounts to £16,168. 18s., out of which an interim dividend at the rate of 4 per cent. per annum for the half year ending June 30, 1894, has been distributed. The Board now recommend the payment of a dividend at the rate of 6 per cent. per annum, less income tax, for the past half-year, making 5 per cent. for the year ending December 31 last, carrying forward a balance of £1,781. In accordance with the articles of association, two of the directors, Edmund Boulnois, Esq., M.P., and Sir Douglas Galton, K.C.B., F.R.S., retire, but, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also retire, but, being eligible, offer themselves for re-election.

Revenue Account, Year ending Dec. 31, 1894.

Dr.	£ s. d.	£ s. d.
A.—To Generation of Electricity.		
Coal, carriage, unloading, etc.	5,841 19 2	
Oil, waste, water, and engine-room stores	1,227 17 6	
Proportion of salaries of engineers and officers	1,589 13 6	
Wages, etc., at generating stations	4,755 14 11	
Repairs and maintenance—buildings, £40. 14s. 7d.; plant, £1,430. 9s.; instruments, £6. 16s. 10d.	1,478 0 5	
		14,893 5 6
B.—To Distribution of Electricity.		
Repairs and maintenance of mains—materials, etc., £17. 16s. 2d.; proportion of salaries of officers, £110; Wages, etc., £410. 10s. 11d.	538 7 1	
Repairs and maintenance of meters—materials, etc., £144. 6s. 2d.; wages, etc., £202. 8s.	346 14 2	
		885 1 3
C.—To Rents, Rates, and Taxes.		
Rents	952 13 3	
Rates and taxes	1,908 11 10	
		2,861 5 1
D.—To Management Expenses.		
Directors' fees	800 0 0	
Salaries of manager, engineer-in-chief, secretary, clerks, etc.	3,680 0 6	
Stationery and printing	267 17 0	
General charges and office expenses	457 0 1	
Auditors of Company	52 10 0	
Wages of meter readers, inspectors, etc	772 0 9	
Depreciation on office furniture	100 0 0	
		6,129 8 4
E.—To Law and Parliamentary Charges.		
General law charges		43 2 0
F.—To Depreciation, etc.		
Sinking fund	2 500 0 0	
Depreciation account	2,500 0 0	
		5,000 0 0
G.—To Special Charges.		
Insurance	219 10 3	
Board of Trade audit	60 0 10	
		279 11 1
Total expenditure		30,091 13 3
Balance to net revenue account		22,600 16 10
		£52 692 10 1

Cr.	£ s. d.
Sale of current by meter	50 686 14 5
,, ,, contract	42 14 9
	50,729 9 2
Less bad and doubtful debts	560 19 5
	50,168 9 9
Rental of meters, etc., on consumers' premises	2 477 15 4
Transfer fees	46 5 0
	£52 692 10 1

Dr. Net Revenue Account	£ s. d.
Interest on mortgage debentures	4 650 16 4
Less income tax	154 2 5
	4,496 13 11
Interest on sundry accounts	271 13 2
	4,768 7 1
Amount written off preliminary expenses account	2,000 0 0
Amount written off patents and law charges account	1,570 5 0
Balance carried to general balance-sheet	16,168 18 8
	£24,507 10 9

Cr.	£ s. d.
Balance from last account	8,460 4 11
Less dividend for half-year to December 31, 1893, at 5 per cent. per annum	£7,487 10 0
Less income tax	218 17 0
	7,268 13 0
	1,191 11 11
Balance from revenue account	22,600 16 10
Interest on temporary deposits	39 0 10
Rents paid and accrued	676 1 2
	£24,507 10 9

Dr. General Balance-sheet, Dec 31, 1894	£ s. d.
Capital account	400,000 0 0
Amounts received in advance in respect of new shares	2 324 0 0
Temporary loan from bankers	15,000 0 0
Sundry creditors	2,912 6 2
Debenture interest accrued	£2,323 10 0
Less income tax	77 9 0
	2,246 1 0
Depreciation account	8,821 0 0
Sinking fund	3,773 0 0
Net revenue account	£16 168 18 8
Less interim dividend to June 30, 1894, at the rate of 4 per cent. per annum, £5,990. 3s. 10d.; less income tax, £187. 13s. 8d.	5,802 10 2
	10,366 8 6
	£445,442 15 8

Cr.	£ s. d.
Capital account	411,018 18 1
Stores in hand	1,440 14 9
Sundry debtors	18,612 12 2
Cash at bankers (Messrs. Barclay, Ransom, and Co.)	7,102 2 8
Cash in hand	21 0 9
Deposits with vestries, etc.	451 7 0
Preliminary expenses and suspense account	£7,555 12 7
Less amount written off for 1894	2,000 0 0
	5,555 12 7
Payments for plant, etc., under agreement	1,240 7 8
	£445,442 15 8

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STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., YEAR ENDING DEC. 31, 1894.

Quantity utilised :		
Board of Trade units generated		2,582,801
Sold to consumers	2,173,298	
Used on works for lighting, meter testing, etc	40,044	2,213,342
Quantity expended in distribution :		
In batteries	17,655	
In feeders	296,969	314,624
Total quantity accounted for		2,527,966
Quantity unaccounted for		54,895
Number of lamps on circuit, December 31, 1894		167,703

The annual general meeting of this Company was held on Wednesday at the offices, Eccleston-place, Mr. J. H. Powell occupying the chair in the absence, through illness, of the chairman of the Company, Lord Suffield.

The **Chairman**, in moving the adoption of the report and accounts, said that when the Corporation was first started the principal aim of the directors was to give a constant, safe, and bright light without danger. In carrying out their system they had the advice of an able consulting electrical engineer and architect. They had been so successful in five years that their gross revenue was now £52,692, and this had been obtained not by any sudden turn of tide. The increase last year was greater than before, the advance amounting to £9,000, whereas two years ago it was less than £7,000. A diagram on the wall showed a constant increase in the demand for light, and a correspondingly slighter, but equally constant, increase in the number of lamps installed, which showed that the public had an increased appreciation of their efforts. He had been told by a friend that the question had to be solved of making the undertaking pay, and they had done this by paying a dividend for the half-year at the rate of 6 per cent. The ratio of expenses to income, which had been 59·4 per cent., had now come down to 45·5 per cent., notwithstanding the fact that the price for current had been reduced from 8d. to 6d. This reduction had been a wise stroke of policy, as it had induced fresh customers to come, and made waverers into good friends. In 1892 the expenditure per lamp was £3·56, whereas it was now £2·45, and the directors believed this would be further reduced, owing to their having had to lay down mains in the past in excess of the demand. But it was necessary to do this so as to be able to take on any number of lamps which might be asked for. No metropolitan company spent so little per lamp, and the expenditure in this way would compare favourably with that of any company in the country. Not only had the ratio of expenses decreased, but the actual cost of distribution had decreased. The revenue had advanced by £9,000, and the actual amount of expenses by £500. This reduction was mainly due to the skill and care of the engineers and workmen. They had instituted a system of bonus which seemed to have acted well not only as regarded the engineers and men, but also as regarded the shareholders and consumers. The net revenue amounted to more than 6¼ on the whole of the shares, but deductions had been made. They had done away with the item of cost of patents (which was not an asset); preliminary expenses to the extent of £2,000 had been written off; and £2,500 had been carried to a sinking fund, as the Company's concession was only for 42 years. The directors thought they should provide for the future, as at the end of the period they would not be paid compensation for their business, but only for the plant at a worn-out price. This real reserve fund at the rate of £2,500 a year would, at compound interest, leave a substantial sum for the shareholders at the end of the concession. Prof. Kennedy had also pointed out to them that in the possible event of a new system being invented within, say, 20 years, the Company could utilise this reserve fund for new discoveries, and thus really stand as a new company. Besides, the reserve strengthened the Company at all points.

Mr. E. Boulnois, M.P., seconded the motion, which was adopted.

Mr. Powell proposed, and **Mr. Hayes Fisher** seconded, the distribution of a dividend at the rate of 6 per cent. per annum for the half-year, which was agreed to.

Mr. E. Boulnois, M.P., and Sir Douglas Galton were re-elected directors.

On the motion of **Sir Mark Stewart**, it was agreed to let the matter of the appointment of the Company's auditors stand over until an adjourned meeting.

Mr. S. R. Scott moved, and **Mr. G. White** seconded, that the directors' fees be raised from £800 to £1,500 a year, the increase to date from the beginning of last year. This was unanimously approved of.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Alderman T. G. Gibson, J.P. (chairman), Dr. Robt. Spence Watson, Dr. J. T. Merz, Colonel F. F. Sheppee, J. Tennant, Esq., J. H. Armstrong, Esq.

Report of the directors presented to the seventh general meeting of the shareholders.

The amount of share capital subscribed stands at £38,905, of which £34,250 has been paid. This is an increase of £5,735 for the year. The directors were able during the year to arrange for the renewal of the expiring 6 per cent. mortgage debenture issue, amounting to £15,000, at the reduced rate of 5 per cent. A further issue ranking *pari passu* therewith has also been made to the extent of £5,000, of which sum £2,200 was received during the latter part of 1893, in anticipation of the new issue. The total amount of mortgage debentures now represents a sum of £20,000, repayable on September 1, 1899, and bearing interest at 5 per cent. per annum. The expenditure on buildings and plant during the year has been increased by the further cost of completing the condensing plant and extensions of mains. The directors have pleasure in reporting that the condensing plant is now in full operation, and the saving already effected in fuel and water, in their opinion, quite justifies the amount expended. The profit and loss account shows a gross profit of £2,930. 13s. 2d., against £2,459. 16s. 3d. in 1893; the units sold have been 401,066, against 360,467. The net profit for the year is £1,632. 10s., against £1,417. 4s. 11d. in 1895, the charge for interest, owing to increased loan capital, having been £1,298. 3s. 2d., against £1,042. 11s. 4d. in 1893. The directors have transferred the sum of £500 to the reserve fund account, and recommend the payment of a dividend at the rate of 4 per cent per annum, less income tax, of which an interim dividend for the half-year at the same rate was paid on July 18 last. This will absorb in all £1,645. 1s. 9d., leaving a surplus of £288. 4s. to be carried forward to the next year's account. In order to meet the views of the Board of Trade, whose auditor has made a detailed examination of the Company's accounts up to December 31, 1893, an account has been opened, styled "capital expenditure suspense account," to which have been transferred all items of preliminary and formation expenses and extraordinary expenditure necessary to the development of the Company. The transfers to this account represent in total £3,004. 3s. 7d., against which a sum of £1,000 has been transferred from the reserve fund, and it is intended to extinguish the balance of £2,004. 3s. 7d. from time to time out of future profits. The retiring directors are Dr. J. T. Merz and Colonel F. F. Sheppee, who are eligible, and offer themselves for re-election. The auditor, Mr. Thos. Harrison, also retires.

BALANCE-SHEET, DEC. 31, 1894.

Capital and Liabilities.	£	s.	d.
Nominal capital—10,000 shares of £5 each	50,000	0	0
Issued and allotted, 7,781 shares, with £4 per share called up £31,124 0 0			
Add calls paid in advance 3,126 0 0	34,250	0	0
Five per cent. mortgage debentures	20,000	0	0
Creditors on sundry accounts 3,594 1 9			
Bank overdraft 1,013 19 4	4,608	1	1
Reserve fund account, as at December 31, 1893 600 0 0			
Added from 1893 profits 300 0 0			
Added from 1894 profits 500 0 0			
1,400 0 0			
Less transfer to capital expenditure suspense account 1,000 0 0	400	0	0
Profit and loss account, balance as per directors' report of January 25, 1894 300 15 9			
Profit for year to date 1,632 10 0			
1,933 5 9			
Less transfer to reserve, £500; interim dividend at 4 per cent. per annum for half-year to June 30, 1894, £544 1s. 9d. 1,044 1 9	889	4	0
	£60,147	5	1

Property and Assets.	£	s.	d.
Buildings and plant, as at December 31, 1893 £36,444 7 8			
Additions to date 5,342 17 4	41,787	5	0
Meters, transformers, etc., as at December 31, 1893 5,972 4 2			
Additions to date 1,582 12 5	7,554	16	7
Land purchased, as at December 31, 1893	1,639	10	0
Cost of provisional order	659	14	11
	51,641	6	6
Preliminary and formation expenses, as at December 31, 1893 959 1 7			
Transferred from other accounts 107 0 8			
Further expenditure to date 57 10 7			
1,123 12 10			
Preparatory and experimental work, transferred from other accounts 1,880 10 9			
3,004 3 7			
Less transfer from reserve 1,000 0 0	2,004	3	7
Loose plant and tools	447	8	3
Office furniture	110	11	0
Stocks at valuation, and work in progress	3,333	16	4
Debtors on current supply and for work done, etc.	2,550	14	6
Cash in hand	59	4	11
	£60,147	5	1

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PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1894.

Dr.	£	s.	d.	£	s.	d.
Station charges—salaries, wages, coal, water, and maintenance				2,737	4	6
Street charges—salaries and maintenance				634	11	8
Rents, rates, taxes, and insurance				425	0	4
General charges—Directors' remuneration	£131	5	0			
Office salaries, legal and accountancy charges, stationery, stamps, telegrams, etc.	760	6	2			
				891	11	2
Balance carried down				2,930	13	2
				£7,619	0	10

Interest—	£	s.	d.	£	s.	d.
On debentures	954	18	2			
On calls paid in advance	120	14	10			
On deposits, etc.	222	10	2			
				1,298	3	2
Balance carried down				1,632	10	0
				£2,930	13	2

Cr.	£	s.	d.
Current supply—Household	6,413	14	4
Public lamps	535	15	2
	6,949	9	6
Apparatus rent	663	19	2
Profit on sale of lamps	4	12	2
Transfer fees	1	0	0
	£7,619	0	10

	£	s.	d.
Balance brought down, being gross profit for year	2,930	13	2
	£2,930	13	2

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Sir David L. Salomons, Bart., chairman; the Earl of Suffolk and Berkshire; Joseph Bevan Braithwaite, jun.; Edward Lucas; Colonel B. H. Martindale, C.B.; Frederick W. Reynolds. Frank Bailey, engineer to the Company. J. Cecil Bull, manager and secretary.

Report of the directors to be presented to the shareholders at the ordinary general meeting of the Company to be held at Winchester House, Old Broad street, E.C., on Wednesday, February 27, 1895, at 2.30 p.m.

Capital.—The expenditure on capital account during the year ended December 31, 1894, amounted to £280,532. 9s. Details of this further outlay are given in the capital account. During the year 5 per cent. debenture stock to the extent of £300 000 has been issued at premiums amounting to £71,000. The first issue of £100,000 is already quoted in the Stock Exchange official list, and application has been made for a quotation for the second issue of £200,000. The directors have been advised that owing to the debenture stock having been made redeemable at £125 per centum after December 31, 1910, the sanction of the shareholders is necessary to the issue of the further stock required to complete the £400,000 mentioned in the original prospectus, and a resolution for this purpose will be submitted to the shareholders.

Revenue.

	£	s.	d.	£	s.	d.
The total revenue for the year was				£69,380	3	3
From which must be deducted the following items charged against revenue:						
Expenses of generation and distribution	£27,983	17	3			
Rents, rates, taxes, and general charges	6,531	3	6			
				34,515	0	9
Leaving a net revenue of				34,865	2	6
To which must be added the balance brought forward from 1893				3,041	14	9
Making a total available revenue of				37,906	17	3
Of this sum the following amounts have been distributed:						
(*a*) Interest on debenture stock to December 31 last	3,154	3	4			
(*b*) Interim dividend on £400,000 6 per cent. preference shares for half-year to June 30 last	12,000	0	0			
				15,154	3	4
Leaving for further distribution				£22,752	13	11

The directors now recommend the following dividends for the past half-year—viz., 6s. per share on the preference shares, being at the rate of 6 per cent. per annum, and 5s. per share on the ordinary shares, being at the rate of 5 per cent. per annum. This will absorb £22,000, leaving a balance of £752. 13s. 11d. to be carried forward. Out of the premiums already received on the issues of debenture stock, the directors have decided to write off the whole of the expenses in connection with the issues of ordinary and preference shares, debenture stock, and other preliminary matters, amounting in all to £19,064. 18s. 4d., and to transfer the sum of £1.595. 11s. to the reserve fund, leaving a balance of £44,923. 18s., which it is proposed for the present to carry forward. The necessary provision for depreciation in accordance with the City of London Electric Lighting Act, 1893, has been made. Notwithstanding repeated applications the local authority has not yet given consent as required by the Telegraph Act, 1892, to the use of certain tubes for telephonic purposes. Negotiations are still proceeding. The generation and distribution expenses for the year, including repairs and renewals, were 46 per cent. of the earnings, as compared with 54·2 for 1893. Revenue is now being earned at the estimated rate of over £105,000 per annum gross. The rapid progress made in the Company's business will be readily seen by the following table:

	End of Dec., 1892.	End of Dec., 1893.	End of Dec., 1894.
Estimated gross revenue from private lighting	£16 193	£45,738	£88,000
Estimated gross revenue from public lighting	11,259	12,933	13,600
Number of 8-c p. lamps connected	20,241	65,341	135,460
Number of customers	242	1,080	2,740

Lands and Buildings.—The main buildings now finished will accommodate plant of sufficient capacity for at least 300,000 8-c.p. lamps connected. Possession of Rose's Wharf and premises adjoining the Bankside station has just been obtained; this site will be utilised in due course for the business of the Company. The whole of the 22 transformer stations are now in operation; they will accommodate equipment for the service of at least 400,000 8-c.p. lamps connected.

Generating Plant.—The plant already in position is of a capacity of 150,000 8-c.p. lamps, and the further machinery in course of construction by the contractors will be erected during the current year. The arc lighting plant has worked satisfactorily throughout the year. The total number of units sold during the year was 2,602,217.

Street Work.—This work is now practically complete. Further expenditure for cables will be limited to primary mains, feeders, and service conductors, which will be provided as from time to time required.

Private Lighting.—Nearly 3,000 private consumers, representing a total of 142,500 8-c.p. lamps, are being supplied with current. Applications continue to come in satisfactorily, the total received to date being equal to the supply of current for 151,000 8 c.p. lamps.

Public Lighting.—The Company is still awaiting the order of the Commissioners of Sewers to proceed with the lighting of the lesser streets, for which the necessary plant was in position a year ago.

Staff.—The directors have appointed Mr. Frank Bailey to be engineer to the Company in the place of Mr David Cook, resigned; Mr. J. Cecil Bull, the secretary, to be also commercial manager.

Directors and Auditors.—In accordance with the articles of association, two of the directors, Mr. Edward Lucas and Colonel B. H. Martindale, C B., retire, and, being eligible, they offer themselves for re-election. Messrs. W. H. Pannell and Co. retire, and, being eligible, offer themselves for re-election.

Dr. CAPITAL ACCOUNT, DEC. 31, 1894.

Expenditure.	Public lighting. £	s.	d.	Private lighting. £	s.	d.
Machinery and plant: boilers, pumping, feed-heating appliances, engines, arc dynamos, alternators, and exciters	34,095	10	7	197,006	4	4
Mains (including cost of laying and repaving)	39,662	0	3	269,574	6	11
Transformers and accessories	—			59,102	10	11
Meters and electrical instruments	147	3	11	14,458	19	5
Lamp-posts, lanterns, lamps, and accessories	24,376	13	10	1,182	8	8
Tools and plant	1,212	9	5	1,972	9	3
Cost of obtaining three provisional orders under agreements with contractors, and expenses in connection with "1893" Act	3,277	4	9	3,277	4	9
Office furniture	229	8	10	917	15	3
Proportion of management and general expenses chargeable to capital—rents, rates and taxes, salaries, directors' fees, remuneration of former chief engineer, professional charges, etc., as adopted by Board and approved by auditors	6,321	19	7	26,420	2	10
Billiter-buildings installation	—			3,587	7	4
Cooking and heating appliances and development	—			1,139	8	0
	109,322	11	2	578,638	17	8
Total of public and private lighting				687,961	8	10
Buildings				118,880	17	11
Freehold and leasehold land, including law charges incidental to acquisition				98,028	9	2

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	£ s. d.
Southwark lighting—	
Cost of obtaining provisional order, expenditure on mains, etc.	15,078 13 11
Total for electric lighting purposes	919,949 9 10
Expenditure on conduits for telephonic purposes	69,504 10 0
Total carried to balance-sheet	989,453 19 10
Balance of capital account	—
	£989,453 19 10

Cr. Receipts.	£ s. d.
40,000 ordinary shares of £10 each	400,000 0 0
40,000 6 per cent. preference shares of £10 each	400,000 0 0
5 per cent. debenture stock	172,960 0 0
Total receipts	972,960 0 0
Balance	16,493 19 10
	£989,453 19 10

REVENUE ACCOUNT FOR 12 MONTHS ENDED DEC. 31, 1894.

Dr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Generation of electricity—		
Coal and other fuel, including dues, carriage, unloading, storing and all expenses of placing the same on works	3,948 14 6	10,481 2 8
Oil, waste, and engine-room stores	343 13 1	916 5 8
Water	286 6 1	763 1 1
Salaries of station engineers and assistants	698 1 0	1,396 1 10
Wages and gratuities at generating stations	1,487 2 3	2,839 4 1
Repairs and maintenance as follow: * Buildings, £497. 7s.; boilers, heaters, etc., £463. 7s. 5d.; engines and condensers, £587. 15s. 8d.; dynamos and exciters, £296. 12s.; other machinery, instruments, and tools, £134. 14s. 11d.		
Total generation expenses	£6,763 16 11	£16,395 15 4
Distribution of electricity—		
Proportion of salaries of officers, as adopted by Board and approved by auditors	420 18 6	526 3 1
Wages and gratuities to linesmen, fitters, and trimmers of lamps	1,197 13 6	110 4 9
Wages and gratuities to transformer men	—	1,359 11 5
*Repairs, maintenance, and renewals of mains, lamp-posts, and transformers £835 1 3		
Carbons and materials for street and other lamps	1,143 8 3	66 5 6
Total for generation and distribution	9,525 17 2	18,458 0 1
Proportion of rents, rates, and taxes—		
Rents payable	545 17 9	1,091 15 6
Rates, taxes, and lighting	324 8 11	648 17 11
Proportion of management expenses—		
Directors' remuneration, salaries of manager, secretary, accountant, clerks, collectors, etc.	808 7 5	1,616 14 9
Printing and stationery	84 10 4	169 0 10
General establishment charges	104 6 3	208 12 6
Auditors' fees	17 10 0	35 0 0
Trustees' fees	35 0 0	70 0 0
Legal charges	20 19 2	41 18 4
Special charges—		
Allowances, deductions, and bad debts	138 13 4	377 10 8
Insurances	63 19 11	127 19 11
Total expenditure	11,669 10 3	22,845 10 6
Total for public and private lighting		34,515 0 9
Balance, being revenue for period carried to net revenue account		33,045 6 2
		£67,560 6 11

Cr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Sale of current	—	50,485 3 3
Current consumed on works (at cost)	—	1,097 16 0
Revenue under contracts	12,785 17 8	—
Meter rentals	—	2,523 3 8
Rents receivable	137 6 8	274 13 4
Transfer fees	47 15 0	95 10 0
Other receipts	—	113 1 4
	12,970 19 4	54,589 7 7
Total for public and private lighting		£67,560 6 11

* These amounts and also the statutory depreciation have been provided out of the depreciation reserve funds.

Dr. NET REVENUE ACCOUNT.	£ s. d.
Interest on 5 per cent. debenture stock—	
To June 30, 1894	654 3 4
To December 31, 1894	2,500 0 0
	3,154 3 0
Balance as per general balance-sheet	34,752 13 11
	£37,906 17 3

Cr.	£ s. d.
Balance from last account	3,041 14 9
Balance from revenue account to December 31, 1894, as above	33,045 6 2
Interest on deposits, investments, etc.	1,819 16 4
	£37,906 17 3

GENERAL BALANCE-SHEET AS AT DEC. 31, 1894.

Dr. Liabilities, etc.		£ s. d.
Capital account		972,960 0 0
Sundry tradesmen and others, due on construction of plant, machinery, fuel, stores, etc.		11,875 12 10
Sundry creditors on open accounts		7,662 11 1
Sundry deposits—Consumers	£168 3 0	
Others	1,000 0 0	
		1,168 3 0
Temporary loan from bankers		30,000 0 0
Depreciation reserve funds—No. 1	675 11 1	
Do. do. No. 1A.	27,841 18 11	
Do. do. No. 2	7,820 11 0	
Reserve fund	2,432 11 9	
		38,770 12 9
Premiums on issue of £300,000 debenture stock and dividends thereon	71,288 7 4	
Less (a) outstanding, £5,714; (b) expenses in connection with issues of ordinary and preference shares, debenture stock, and other matters written off, £19,064. 18s. 4d.; (c) transferred to reserve fund, £1,585. 11s.	26,364 9 4	
		44,923 18 0
Net revenue account—Balance at credit thereof	34,752 13 11	
Less interim dividend on £400,000 preference shares to June 30, 1894	12,000 0 0	
Balance available for distribution as proposed in report		22,752 13 11
		£1,130,113 11 7

Note.—Under existing contracts relating to the equipment of the stations and other works there are contingent liabilities which become due only after completion and final acceptance of the work.

Cr. Assets.	£ s. d.
Capital expenditure	989,453 19 10
Stores on hand	26,704 3 7
Sundry amounts paid on account of contracts in course of completion	411 11 10
Sundry debtors for current supplied	32,457 19 9
Other debtors	3,912 17 3
Suspense accounts	1,904 5 8
Cash at bankers and on hand	13,242 1 6
Sundry deposits under provisional orders, etc., and interest accrued thereon	6,469 4 10
Investments—(a) depreciation and reserve funds invested in £40,533. 6s. 2¾ per cent. consols at about 98 5/16, and dividend accrued thereon, £40,269. 7s. 6d.; (b) premiums received in respect of first issue of debenture stock invested in £16,106. 6s. 2½ per cent. Metropolitan Consolidated Stock at 94⅞ per cent., and dividends thereon, £15,287. 19s. 10d.	55,557 7 4
	£1,130,113 11 7

CITY OF BATH ELECTRIC LIGHTING AND ENGINEERING COMPANY, LIMITED.

The fourth annual general meeting of this Company was held at Bath, Mr. T. O. Callender occupying the chair.

The **Chairman**, in moving the adoption of the report and accounts, which were published in our issue of 8th inst., said the directors could come before the shareholders with a certain amount of confidence and satisfaction, and he was sure next year they would have better results to lay before them. They were always sorry not to be able to recommend a dividend: there was sufficient to pay a small one, but after careful consideration they thought it would be the true policy to carry forward the balance. Referring to the improvement of the plant, the Chairman said they had fitted up some of their furnaces for liquid fuel, which already had been of the greatest advantage in the difficult season through which they had passed. It was their intention to extend that system a little later on, and they also saw their way to improving the plant and appliances inside and outside the station. They thought it would be money well spent. It was a matter for congratulation that the citizens were adopting the light more freely than in the past. He referred

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in terms of warm praise to the efforts of their engineer and his staff, especially during the flood, and said the directors wished to bear public testimony to their appreciation of Mr. Metzger's services. As the question of the provisional order was quite *sub judice*, it would be better to say nothing about it. They had every reason to be satisfied with what had been done, and they were quite content to leave it in the hands of Mr. Titley and Mr. Morse (the London agent) and the Board of Trade.

Mr. Van Tromp seconded the motion, which was carried.

Mr. T. O. Callender and Mr. C. J. Wharton, the retiring directors, were re-elected.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER COMPANY, LIMITED.

Directors: Alexander Bruce, J.P. (chairman), Ballaquayle Villa, Douglas; Frederick George Callow, Ballacurrie, Onchan, Douglas; John Allen Mylrea, J.P., M.H.K., Derby-terrace, Douglas; Dr. Edward Hopkinson (Messrs. Mather and Platt, Limited), Manchester; Alfred Jones Lusty, 150, Leadenhall-street, London; William Parke J. Pittar, The Cliffe, Douglas; Richard Farrell, LL.D., Victoria-road, Douglas. J. Aldworth, manager. W. E. Young, secretary.

Report of the directors presented to the shareholders at the ordinary general meeting of the Company held on Wednesday last.

The available profit from May 1 to December 31, 1894, including a sum of £526. 12s., being premiums on shares sold, amounts to £11,034. 0s. 10d. Out of this profit an interim dividend of 6 per cent. per annum on the preference shares, and 7½ per cent. per annum on the ordinary shares, amounting to £4,213. 15s. 3d., was paid for the half-year ending October 31; also a sum of £1,666. 13s. 4d., being interest on debentures up to December 31 last, and £43. 9s. 10d. interest on mortgages (balance), making a total of £5,923. 18s. 5d. The directors recommend that a further dividend at the rate of 6 per cent. per annum on the preference shares and 7½ per cent. per annum on the ordinary shares, for the remaining portion of the financial year ending December 31, amounting to £1,437. 10s., be now declared and payable on the 28th inst.; that £2,000 be carried to a reserve and renewal fund; and that the balance of £1,672. 12s. 5d. be carried to profit and loss new account for the present year. Owing to unavoidable delays, the passenger traffic between Groudle and Laxey was not commenced until July 28 last, and this part of the line being the most important section, the profits are much less than what may be anticipated in future years. Last season, owing to the limited number of motor cars, the management was unable to cope with the passenger traffic. The Board, therefore, has ordered four new open motor cars of an improved type and larger carrying capacity from Messrs. G. F. Milnes and Co., Birkenhead, and the electrical equipment from Messrs. Mather and Platt, Limited, Salford. The passenger traffic on the electric line during the winter months has exceeded the expectations of the directors, who have also to report that they are confident that the revenue to be derived from goods and merchandise traffic will be substantial. Arrangements are being made to meet the wants of the districts through which the tramway passes, together with the surrounding neighbourhoods. Negotiations are pending for the erection of a convenient station and all necessary accommodation at the Laxey terminus, and arrangements are now in progress for an approach road to the terminus. This road will lead into the heart of Laxey, and will meet the fullest demands for vehicular and pedestrian traffic. Convenient waiting-rooms at important points along the line will also be shortly erected. An arrangement has been made between this Company and the Derby Castle Company for the erection of a large waiting-room and other accommodation at the Douglas terminus. After providing for the dividends on preference and ordinary shares, and interest on debentures up to December 31, and carrying £2,000 to reserve and renewal fund, an available sum of £4,080 11s 10d (over and above the balance being carried forward, of £1,672 12s. 5d.) remains in hand to meet any necessary outlay on rolling-stock, etc. The retiring directors this year are Messrs. Alexander Bruce and F. G. Callow, both of whom are eligible and offer themselves for re election. The auditors, Messrs. Aldred, Turner, and Co., also retire and offer themselves for re-election.

Electrical Engineer's Report.

I have made an inspection of the plant at the generating stations at Douglas and Laxey, and also of the line and rolling-stock. I have much pleasure in reporting that I have found the whole in good condition, and maintained in a manner which reflects much credit upon the general manager and his engineering staff. I also, in particular, examined the accumulator station at Groudle. The battery is in excellent condition, and has been of great service, not only as a reserve and regulator of the load upon the engines, but also for working the winter traffic through a large portion of each day. thus reducing the time during which the generating plant at Douglas need be worked, and consequently effecting a great economy in working expenses. Edward Hopkinson.

Balance-sheet, Dec. 31, 1894.

Capital and Liabilities.

	£	s.	d.
Share capital issued—			
50,000 6 per cent. preference shares of £1 each (fully paid up)	50,000	0	0
75,000 ordinary shares of £1 each (fully paid up)	75,000	0	0
First mortgage debentures (5 per cent.)	50,000	0	0
Total capital raised	£175,000	0	0
Mortgage on house property	1,100	0	0
Debenture interest owing	1,250	0	0
Sundry creditors	584	16	8
Total	£177,943	16	8
Premiums on shares sold	526	12	0
Revenue account—viz., profit, after deducting working expenses (for eight months ending December 31) £10,507 8 10			
Deduct interest on mortgages (balance), £43 9s. 10d.; interest on debentures to December 31, £1,666. 13s. 4d.; interim dividend paid to October 31, £4,213. 15s. 3d. 5,923 18 5			
Balance available for further dividend, renewal fund, etc.	4,583	10	5
	£183,044	19	1

Property and Assets.	£	s.	d.
Purchase of property, after deducting amount of cash, stores, etc, included in the original cost	170,251	10	10
Additional outlay on buildings, plant, etc.	667	17	4
Total outlay on capital account	£170,919	8	2
Sundry debtors	214	19	4
Stock of material, stores, etc., valued at	1,353	6	6
Stock of 39 horses, valued at	931	0	0
Cash at bankers and in hand	9 626	5	1
	£183,044	19	1

The first annual meeting was held on Wednesday at Douglas.

Mr. A. Bruce, chairman, in proposing the adoption of the report, congratulated the shareholders on the magnificent position of the Company, and pointed out that with the interim dividend already paid and that proposed the shareholders were paid the handsome dividend of 12 per cent. on the preference and 15 on the ordinary shares. They proposed to carry forward £2,000 to reserve, and £1,672 to profit and loss. He alluded to the prospective public improvements, which would increase the number of visitors and add to the revenue of the Company.

The report was adopted, and Messrs. A. Bruce and F. G. Callow were re-elected directors.

Mr. J. Aldworth, the manager, said that during the eight months the system had been working, a million and a quarter persons had been carried without injury to life or limb, showing the efficiency with which the line was worked.

CAMBRIDGE ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: D. Munsey, Esq. (chairman), the Hon. C. A. Parsons (managing director), Sir B C. Browne, Wm. C. Hall, Esq., P. W. Latham, Esq., M.D., John B Simpson, Esq., G. Whitmore, Esq John H. Barker (general manager and secretary).

Report of the directors to be presented to the shareholders at the third annual general meeting to be held at the offices of the Company at Cambridge on Wednesday, February 27, at 12 o'clock.

During the last 12 months lamps equivalent to 3 644 of 8 c.p. have been connected to the Company's mains, making a total at the present time equal to 11,644 lamps of 8 c p. The electric light has during the year been extended throughout Caius College and Sidney College. There is every prospect of a large increase in lamps during the present year. During the past year 3,688 yards of main conduit pipe has been laid in Newnham and other districts, making at the present time a total of 12,146 yards. Since October, 1894, the supply of current has been continuous day and night. In order to maintain the supply most economically, as well as to meet the increasing demand for current, your directors have decided to add a small day-load generating plant and an additional boiler. The Company has made a profit on the year's working of £933. 1s. 1d., which, added to £268. 10s. 11d. brought forward from last year, leaves a balance of £1,201. 12s. Your directors therefore advise the payment of a dividend of 2½ per cent, absorbing £575. 18s., which, with £350. 17s. 7d. debenture interest, leaves £274. 16s. 5d. for depreciation, writing off, etc. Your directors anticipate that the further increase of lamps during the present year and the addition of the day-load plant will enable them to recommend an increased dividend for the current year. Sir B. C. Browne and Mr. D. Munsey retire by rotation, but are eligible, and offer themselves for re-election. The auditor, Mr. Arthur Rutter, also offers himself for re-election.

Balance-sheet, Dec. 31, 1894

		£	s.	d.
Capital—5,000 shares at £10 each		50,000	0	0
3,582 shares issued, £8 called up		28,656	0	0
Debentures, £4,000 at 4 per cent.		4,000	0	0
Amount for current received in advance	£62 11 7			
Creditors	175 13 9			
Bankers	72 16 2			
		311	1	6
Profit and loss account—profit for year ending December 31, 1894, as per statement	313 12 7			
Balance from last year	268 10 11			
		582	3	6
		£33,549	5	0

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	£	s.	d
Amount expended to date on land, buildings, plant, pipes, cables, meters, transformers, electrical instruments, public lamps, etc.....	28,745	6	1
Less depreciation fund	100	0	0
	28 645	0	0
Provisional order..	1,005	0	0
Preliminary expenses £1,752 14 8			
Less amount written off 168 10 11			
	1,584	3	9
Office furniture ...	119	17	4
Stock of stores, etc.	353	19	9
Sundry debtors	1,840	1	5
Cash in hand	0	16	8
	£33,549	5	0

PROFIT AND LOSS ACCOUNT FOR YEAR ENDING DEC. 31, 1894.

	£	s.	d.
Wages, salaries, rents, rates, and taxes	865	17	8
Stores, fuel, and water	1,234	13	5
Repairs and renewals	270	14	9
Stationery and general expenses	90	2	4
Balance carried down	933	1	1
	£3,394	9	3
Electric energy supplied	£3,151	10	8
Meter rents	242	18	7
	£3,394	9	3
Interest on debentures and loans	£350	17	7
Written off formation expenses	168	10	11
Transferred to depreciation fund	100	0	0
Balance carried to balance-sheet	313	12	7
	£933	1	1
By balance brought down.....	£933	1	1
	£933	1	1

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Plymouth.—The Corporation invite tenders by the 28th inst. for the supply of, among others, oils and paints and indiarubber goods.

Seaham (Durham).—Tenders are invited by the 28th inst for lighting the streets and roads of the parish with gas or electricity, for the Seaham Parish Council. Tenders, sealed and endorsed "Parish Lighting," to be sent to the chairman, Rev. D. W. James, of whom any further information may be obtained.

Islington.—Tenders are invited for the supply of alternate-current meters and converters by the Vestry of St. Mary, Islington. Specifications and full particulars may be obtained on application to the electrical engineer, 50, Eden-grove, Holloway, N. Applicants will be required to deposit the sum of £1. 1s., which will be returned on receipt of a *bond fide* tender.

Warrington.—The Sanitary Works Committee of the Corporation desire tenders by the 25th inst. for the supply of a water-tube boiler (of the Babcock and Wilcox type), proposed to be erected at Longford depôt. Specification and drawings may be seen and information obtained on application to Mr. James Deas, manager, Longford depôt, Warrington. Tenders to be sent to Mr. J. Deas, and are to be addressed to the chairman of the Sanitary Works Committee.

RESULTS OF TENDERS.

Southport.—The tender of Mr. J. Partington, of Chadderton, Oldham, has been accepted by the Town Council, at £1 420, for the erection of a chimney stack at the electric light station.

Bristol.—The following is the full list of tenders for installing the electric light at the Guildhall. Mr. F. Proctor is the electrical engineer :

F. W. Ball and Co. (accepted)	£438	18	0
Waring and Co.	440	0	0
Fowler, Lancaster, and Co.	444	0	0
Manchester Ediswan Company	444	2	6
Willway	463	0	0
Palmer	474	0	0
Baker, Newport	489	0	0
Curtis, Hanning, and Co.	500	0	0
Strode and Co.	517	0	0
Crompton and Co.	569	0	0
F. M. Newton	585	0	0
Cox-Walker	626	19	0
Pettit and Hards	645	15	6
Fergus and Co.	693	0	0
King, Mendham, and Co.	778	13	1
Newport Electrical Company	812	0	0
Roger Dawson	1,120	0	0

Edmonton.—A committee of the District Council have recommended the acceptance of the tender of the Consolidated Telephone Construction and Maintenance Company for fire alarms. Before doing this, however, enquiries are to be made of the Local Government Board and of the company with regard to variations of the estimates.

London.—The Metropolitan Asylums Board have accepted the tender of Messrs. F. C. and P. M. Benest, of 30, Cromwell-grove, West Kensington-park, W., to supply and fix overhead electrical fire-alarm wires and posts between the Darenth Schools, the farm buildings, and the Gore Farm Hospital, for the sum of £72; and to maintain in thorough working order, etc., for a period of three years, the whole of the electric bell system throughout the asylum, schools, and pavilions at Darenth for £75 per annum.

BUSINESS NOTES.

Aberdeen.—It is intended to light the infirmary by electricity.

Northwich.—A local electric lighting company, it is reported, is to be formed.

Crewe.—It is probable that the Mechanics' Institute will be lighted by electricity.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3 388.

Dundee.—A further sum of £10,000 is to be borrowed by the Town Council for electric lighting purposes.

St. Pancras.—The Electricity Committee of the Vestry have decided not to abolish meter rentals for the present.

Woking.—The Sanitary and Lighting Committee of the Council have recommended an addition to the number of electric lamps.

Brentwood.—A petition has been presented to the Lighting Inspectors suggesting the lighting of the parish roads by electricity.

Manchester.—The City Council on Wednesday decided to refer to a special committee the question of municipalising the tramways.

Keswick.—The Urban District Council have consented to the application by the local electric lighting company for a provisional order.

Devonshire.—The Lunacy Commissioners of the Devonshire County Council intend to spend £5,000 on the electric lighting of the county asylum.

Stockton-on-Tees.—The Electric Lighting Committee of the Town Council have deferred for six months the consideration of the electric lighting scheme.

Brush Electrical Engineering Company.—The debenture stock transfer books of the Brush Electrical Engineering Company, Limited, are closed from the present to March 2.

West India and Panama Telegraph Company.—For the two weeks ended February 15 the receipts show an increase of £201 as compared with the corresponding period of 1894.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 17th inst. amounted to £843, as compared with £671 in the corresponding week of last year.

Battersea, S.W.—The Vestry last week authorised the Electrical Committee to expend £200 in getting the opinion of experts as to the advisability of using electric light in the parish.

Finchley.—The District Council have instructed Messrs. Sax and Co. to do what is necessary in order to remove defects in the batteries used in connection with the fire brigade telephone service.

Change of Address.—The Magnetite Sewage and Water Purification Company have removed from 19, Bridgewater-chambers, 6, Brown-street, Manchester, to 33, Barton-arcade, Deansgate, Manchester.

Birmingham.—The Technical School Committee of the Town Council have decided to adhere to their recommendation, to which we referred two or three weeks ago, to introduce the electric light in the new technical school.

Southend.—A motion by Councillor Bowmaker for a special committee to consider and report upon the electric lighting of the borough has been carried by the Town Council. The mover said the present gas lighting was a disgrace to the town.

Scarborough.—The Town Council have had before them the subject of the new Gas Bill, in connection with which it was mentioned that there had been during the past year a slight decrease in the quantity of gas used in some streets owing to the electric light.

Electrograph Syndicate, Limited.—This Company has been registered, with a capital of £2,000, for the acquisition of certain English patents relating to a process for marking indelibly paper, fabrics, and other receptive materials, and to turn to account the same.

Dewsbury.—The Town Council have decided to charge a rental equal to 10 per cent on the prime cost for the hire of meters, and to allow discounts on all accounts for the supply of electricity at the same percentage and on the same conditions as in the case of the supply of gas.

Southampton.—Mr. Lamport intimated to the Town Council last week that he did not intend to proceed with a proposition of which he had given notice, that the electric light should be used in the Council-chamber and offices, on condition that the matter was referred to committee.

Alliance Meter Company, Limited.—This Company has been registered, with a capital of £5 000 in £1 shares, to carry into effect an agreement between John Clarke and W. Coward, and to conduct business as ironfounders, mechanical engineers, electrical engineers, gas producers and suppliers, etc.

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Pilbarra Goldfields, Limited.—This Company has been registered to carry on mining business, and, among things, to construct and maintain rail and tram roads, canals, telegraphs, telephones, gas, electric, irrigation, and other works.

Vaughan and Brown, Limited.—This Company has been registered, with a capital of £40,000, to acquire the business of electrical, gas, hot-water, sanitary, and ventilating engineers and art-metal workers, as hitherto carried on at 15, 16, and 17, Kirby-street, Farringdon-road, E.C., under the style of Vaughan and Brown.

Norwegian Agency.—The Unbreakable Pulley and Mill Gearing Company, Limited, of Hyde-road Engineering Works, West Gorton, Manchester, inform us that they have appointed the Amerikanske Maskincompagni Tordenskjolds Plads, Christiania, as their sole agents for the sale of "Gorton" gas-engines for Norway.

City and South London Railway.—The receipts of the Company for the week ended February 17 were £998, against £938 for the corresponding week of 1894, or an increase of £60. The total receipts for the current period of the present half-year are £7,039, against £6,665 in the corresponding period of 1894, an increase of £374.

Hertford.—The Town Council at their last meeting received a report from the Lighting Committee which stated that they had received a tender from the Brush Electrical Engineering Company, Limited, for a complete electric light undertaking, but that this tender has not yet been considered by the committee. The report was agreed to.

Maidstone.—Alderman Long mentioned to the Urban District Council, at a meeting last week, that there was no report from the Electric Lighting Committee. They had a meeting the previous day, but it was not agreed whether the order should be disposed of or not. The committee hoped to make a recommendation to the next meeting of the Council.

Kensington.—The clerk to the Vestry has read a letter from the Board of Trade transmitting copy of a draft provisional order granting to the Notting Hill Electric Lighting Company an extension of their present area of supply under the Notting Hill Electric Lighting Order, 1889, and asking that any observations the Vestry may desire to make thereon may be forwarded at the earliest possible moment.

Post-Office Lighting.—Messrs. W. Curtis and Sons, of 98 and 99, Abbey-street, Dublin, inform us that they have secured the contract for the electric lighting of the Accountant's Department, General Post Office, Dublin. The total number of lamps provided for will be 110, and the work is to be carried out from the designs and under the directions of Mr. J. Howard Pentland, senior surveyor to H.M. Board of Works in Ireland.

Engineer Required.—The services are desired of an engineer, who must be a member of the Institute of Mechanical Engineers and Institute of Civil Engineers, and have had considerable experience in hydraulic, electric lighting, and other machinery, and also in the building of steam tugs, iron barges, etc. Applications are to be sent, by letter in the first instance, stating salary and full particulars, to Wm. Cory and Son, 52, Mark-lane, London.

St. James's, S.W.—The Vestry have resolved on the motion of Mr. Angold, "That it be referred to the Lighting Committee to consider and report (*a*) as to the desirability of lighting the main thoroughfares of the parish, such as Regent-street, Piccadilly, St. James's-street, and Pall-mall, with electric light; (*b*) the best system of electric lighting for such thoroughfares; (*c*) the estimated cost as compared with gas; and (*d*) generally upon the whole question."

Morecambe.—The Sanitary Committee of the District Council have reported that they have received a letter from Mr. J. Imbrie complaining of nuisance at the works of the Morecambe Electric Light and Power Company, Limited, in Edward-street and Union-street. It was resolved, on the motion of Messrs. Lee and Carter, that the matter be referred to the medical officer of health for his report, and that after receiving the same a meeting of the committee be called for directions.

Worcester.—A deputation from the City Council has waited upon the Board of Guardians to invite their adoption of the electric light in the new workhouse buildings. Mr. W. Morris moved that the Building Committee be instructed to enquire into and report to a special meeting on the question. This was agreed to by 23 votes to 5. The directors of the Worcester Theatre Royal have decided to have the auditorium illuminated by the electric light. The lamps will number upwards of 70.

Ship Ventilation.—A new system of improved ship ventilation has recently been introduced by Messrs. Baird, Thompson, and Co., Limited, ventilating engineers, of London and Glasgow. The method has been subjected to severe tests, and has proved very successful. One of the principal Atlantic steamship lines, after trying it on one of their vessels, have already adopted it for the whole of their fleet. It is claimed for the Baird-Thompson system that it is most efficient, economical, and reliable.

Bowness.—The chairman of the Urban District Council recently informed the Council that the manager of the electric light company had been seen, and he had informed them that they were about to put in a new cable. The defect in the light hitherto had been owing to the fact that the existing cable was too weak. The charge to the Council would now be 25 per cent. less than that made to ordinary customers, which was now 10d. per unit. The committee proposed that a meter should be put on the circuit.

New Swindon.—Mr. Batt, at a recent meeting of the Urban District Council, moved the adoption of the Electric Lighting Committee's report, which stated that the committee had fully considered the electrical engineer's report, and also the report of the former Electric Lighting Committee appointed by the late Board, and they considered that the application for a provisional order should be proceeded with. Mr. Protheroe proposed, and Mr. Pryce seconded, the adoption of the report, which was adopted.

Copper.—Copper stocks continue to accumulate, the increase in the first half of this month being 866 tons, and the visible supply is greater than at any time in the past two years. The arrivals from America were considerably smaller than in the corresponding half of January; indeed, it is not because of growing imports, but of diminishing consumption that stocks are increasing. In the first half of January 5,742 tons were delivered, against only 4,206 tons to the 16th of this month; so that the recent spurt in consumption seems to have exhausted itself.

Brighton.—The chairman of the Brighton Grand Hotel Company, Limited, mentioned, at a meeting of the company on Wednesday, that since August last the supply of the electric light in the building had been obtained from the Brighton Corporation, and that so far a total saving of £505 had been effected under this head. Every effort would be made, he stated, to dispose of the private installation plant on favourable terms, and there was reason to believe that the loss in this respect would not be so heavy as was at one time expected.

Blackpool.—In the minutes of the Electric Lighting Committee of the Town Council presented to the latter recently it was recommended that Mr. R. Hammond, consulting engineer, be desired to confer with Major Cardew, the electrical adviser of the Board of Trade, as to a proposed variation of the system by means of which electrical energy is to be supplied by the Corporation. A committee was appointed to confer with and direct the borough surveyor upon the subject of the laying of the electric centre channel of the tramways in Lytham-road.

Yarmouth.—The Corporation have received orders for 2,468 lamps, of which 1,181 have been wired and connected and at work, whilst the others are being rapidly connected up. The plant laid down provides for 4,500 lamps of 8 c.p. Leads have been ordered to be laid down Jetty-road at a cost of £20 to supply customers. Messrs. Crompton's tender to supply carbons at £8. 17s. per 1,000 pairs for one year has been accepted. Permission has been given to Messrs. Palmer Bros. to fix seven electric lamps with shades in front of their establishment.

Portsmouth.—The Portsmouth Electric Lighting Committee have just issued their balance-sheet showing the result of the first half-year's working. It shows an actual working profit of £1,514. 9s. 3d., which, had the undertaking been a private concern, would have provided a 6 per cent. dividend for the shareholders. Being a Corporation concern, however, the money borrowed on capital has to be repaid in a certain number of years, together with the interest, and the amount due for the six months was £1,640. 19s. Thus there was an apparent loss to the public of £126. 9s. 9d.

Douglas (Isle of Man).—The Town Commissioners decided on Wednesday upon the construction of a system of tramways to Upper Douglas, and to grant the use of such tramways to a company that may be formed to work the same for a period of 21 years, the use for the first four years to be free of cost to the company, who in the next 16 years are to pay the Commissioners interest and sinking fund upon the capital expenditure, provided that a satisfactory guarantee is given by the company for the proper working of the lines for the period named, and the repayment of the principal and interest.

Warminster.—The Urban District Council have met, and the chairman, Mr. W. F. Morgan, moved that the Council should apply to the Board of Trade for a license authorising them to produce electric light for public lighting, but on the clerk explaining that a license would cost £100, the Chairman asked for permission to withdraw the proposal till the Board was in a position to undertake the production of the electric light, when it was hoped the money required for carrying it out would be provided out of the current rate, and thereby remove the necessity of obtaining a Board of Trade license.

Radcliffe.—The District Council have held a meeting, at which Mr. Cunliffe, before the Streets Committee's minutes were confirmed, asked if the electric lighting work of the late Local Board had been taken cognisance of. They were under certain obligations in regard to the work, and he understood the Electric Lighting Committee had been merged into the Main Roads and Lighting Committee. The Clerk said there was no special committee for dealing with the electric light question, and he brought it before the Main Roads Committee, as they had to deal with the question of lighting the streets. The minutes were confirmed.

Leeds Tramways.—The Corporation in their Bill before Parliament seek to revise the powers granted to them by the Leeds Corporation Tramways Order, 1888. They ask for power to make a new tramway from the junction of Kirkgate and Call-lane, through York-street, and terminating in Marsh-lane by a junction with the existing line; also one along Burmantofts-street and Beckett-street. The Bill further seeks power to construct stations for generating electrical power for the purpose of working the existing and intended tramways on the sites of the destructors at Wortley and Meanwood-road, and at the sanitary depôt in the Calls.

Hampstead.—The Vestry have received from private consumers £42. 9s. 1d. for electric current and meter rent to December 31. The Lighting Committee have recommended that Messrs. Siemens Bros. and Co. should be asked to keep in stock a mile of each kind of cable for use in future extensions in this parish. The committee are in communication with the Willesden

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District Council on the subject of lighting the High-road, Kilburn, with electric light. The engineer is to prepare a specification for the installation of electric light to the town clock, and Messrs. Verity and Sons, F. Taylor, and W. Thompson have been invited to tender for the same.

Fire Brigade Telephones.—The Fire Brigade Committee of the London County Council on Tuesday reported that they had ascertained that the annual charge for telephonic communication between the street station to be located in Baggallay-street, Mile End, and the nearest fire-engine station will be about £12. 10s. On the establishment of the street station the fire-alarm in Burdett road, for which an annual rent of £7. 15s. is paid, will be dispensed with, and the increased annual cost will therefore be less than £5. They consequently recommended that the street station in Baggallay-street be placed in telephonic communication with the Mile End station.

Arlecdon.—A meeting has been held of the Arlecdon and Frizington Urban District Council, at which Mr. Richards moved that the Board secure the services of a thoroughly practical engineer to come and examine the district and the various watercourses which may be available, and ascertain whether sufficient motive power could be produced by these to light the district with electricity; and that he report on the cost of a scheme for lighting the district by electricity, whether with water power or steam power. The motion was agreed to, and it was agreed that Mr. Kirkbride, Father Hurley, and Mr. Richard should be a committee to consult with Mr. Brodie, the engineer for the Corporation of Whitehaven.

Planet Electrical Engineering Company.—Mr. Hamilton moved before Mr. Justice Stirling on Friday for the appointment of Mr. Claud Scott, secretary of the above Company, as receiver and manager. The plaintiffs were holders of £2,500 debentures of the Company, issued on the usual term that principal becomes due and payable upon default of payment of interest. The debentures were issued in 1893, the interest was payable half-yearly, and no interest had yet been paid. Mr. Sheldon appeared for the Company, and consented to the application. His Lordship thereupon appointed Mr. Scott, but directed that he should not act as manager longer than six weeks without leave of the judge in chambers.

Appointments Vacant.—The Aberdeen Town Council invite applications for the position of electrical engineer. The remuneration offered is £200 per annum, and applications are to reach the Town Clerk not later than Monday next. The person appointed will be required to take charge of the electric lighting department under the superintendent of the Corporation gasworks, act as executive engineer at the station, and devote his whole time to the duties of the appointment.—The Corporation of Cardiff require an electrical engineer to take charge of the central station at a remuneration of £200 per annum. Mr. W. Harpur, the borough engineer, Town Hall, Cardiff, will give any further information on the subject. Applications are to be sent in not later than March 7.

Foyers (Scotland).—The Procurator-Fiscal for the county of Inverness has been asked to furnish a report on the proposed works to be erected at Foyers by the British Aluminium Company. The company have entered into contracts with the proprietors in the district for the acquirement of extensive lands and water rights, and Mr. Charles Innes, solicitor, Inverness, who is representing the company in the North, has been in the Foyers district carrying out the necessary negotiations. Captain Charles Ross, of Balnagowan, who is proprietor of an estate on the banks of the Clyde, has, it is stated, been offered £3,000 per annum for his water rights in the neighbourhood of the famous falls, so that the water might be used for a similar purpose—viz., the production of electricity.

Telephone Cable on Hammersmith Bridge.—A committee of the London County Council have reported that they have had under consideration an application from the National Telephone Company for permission to run a telephone cable between two poles on the east side of Hammersmith Bridge, and they recommended that the application be granted, subject to the payment by the company of a rent of £10 per annum, to the cable being laid and the work being executed to the satisfaction of the chief engineer of the Council, to the company making good at its own sole cost any damage that may be done to the bridge or its approaches in carrying out the work, and to remove the cable on receiving a month's notice from the Council, and that the foregoing conditions be embodied in an agreement to be prepared by the solicitor of the Council.

Whitehaven.—The Town Council have adopted the minutes of the Water and Lighting Committee, which stated that Mr. Brodie had reported that the cost of putting in the electric light at the harbour clock would be £10 and the cost of maintenance and lighting £20 per annum. It was resolved that the surveyor should submit the estimate to the Harbour Commissioners. A letter has been read from Messrs. Siemens Bros. and Co. asking the Corporation to do electric lighting repairs necessary under their contract, and charge them with the cost. The engineer has read to the committee correspondence which has passed between Dr. Hopkinson and himself in reference to additional engines contracted to be supplied by Messrs. Willans and Robinson. The Markets and Buildings Committee have postponed a report on the cost of fitting the Town Hall with the electric light.

Newcastle Contracts.—Messrs. Rowland, Barnett, and Co., Limited, of 8, Mosley-street, Newcastle-on-Tyne, who carried out a small installation at the Silksworth branch of the Ryhope and Silksworth Co-operative Society about two years ago, have been instructed to supply and erect a complete installation at the headquarters, Ryhope. The plant will consist of a 28-kilowatt compound dynamo, about 270 incandescent lamps, and two series arc lamps. This firm are also equipping an electric light plant for the new Catholic church, Felling, consisting of a 12-b.h.p. Tangye gas-engine, one 6½-kilowatt dynamo, a battery of 55 secondary cells, and about 50 lights of from 8 c.p. to 100 c.p. In addition to the above they have on order from the New Olympia, Limited, Newcastle, one 16-kilowatt compound dynamo, switchboards, etc., and 170 16-c p. and three 200-c.p. incandescent lights, and two series arc lamps.

Edinburgh.—At a meeting this week of the Town Council, Mr. Douglas asked what provision was being made to ventilate the electric light mains with the view to prevent gas accumulating. Mr. Mackenzie said that the road boxes were quite necessary, and that there was a large leakage of gas going on continually It had been alleged that electrolysis took place in the conduits, and that the gas thus formed was what caused the explosion, and not coal gas. It had not been proved that one single explosion had taken place in this country through this cause, and only in a few cases had the gas mixture been fired by electric mains sparking. The electric light department were quite alive to the danger, and were taking the best steps they could think of to guard against it. There was to be a conference between representatives from the Gas Commission and representatives of the Electric Light Committee to try and arrive at some common understanding.

Dublin.—A most important notice was read at the last meeting of the Dalkey Commissioners from Mr. Clifford Robinson, C.E., managing director of the Southern District Tramway Company, informing them that the electric railway between Dalkey and Dublin would be commenced at once. It had been decided to begin making the line on February 1, but owing to the severe frost it was found impossible to break up the roads. It is hoped that by March 1 the weather will have so far improved as to permit of operations being commenced. The Dalkey Commissioners do not intend interfering with the proposed arrangement of having the electric wires overhead, which is considered more convenient than carrying them underground. The directors of the Dublin United Tramways Company, after a careful inspection of the leading systems on the Continent, have called in Mr. Robert Hammond, of London, to report to them as to the best means of applying electric traction to their undertaking in Dublin.

Huddersfield.—Attention was drawn by Mr. Oxley at a meeting of the Town Council on Wednesday to a statement in the minutes of the Electric Lighting Committee that there was a deficiency on the revenue account for the year ended December 31 last of £2,065 4s. 9d, and that the Finance Committee should be asked to provide for the deficiency. As the representative of an outdistrict which had had to pay 3s 3d per 1,000ft. for its gas, whereas the central parts of the borough paid 2s 9d, he strongly objected to that district being called upon to help to pay for the deficit on electric lighting when they received no benefit from the electric light. He moved that the subject be referred to the committee. Mr. Broadbent seconded this. Mr. Calvert, chairman of the committee, said the interest and sinking fund on the works amounted to nearly £3,400. If they had been a private company instead of a corporation they would have made a profit of £1,400. As they had to repay their money in 15 years, they had to pay an abnormal amount to the sinking fund. In 15 years' time, with the present output, they would be able to make a profit of £3,000 a year. The motion was withdrawn, and the recommendation of the committee was adopted.

Telephone Tubes in the City.—On Tuesday a meeting of the City Commission of Sewers was held, when Mr. Johnson asked whether any progress had been made with regard to negotiations between the Court and the companies on the question of the use of the telephone tubes, in return for which concession the ratepayers were promised a revenue of £1,000 or £2,000 a year. Mr. Berridge said the matter would be discussed at the next meeting of the committee Mr. Barham warned the Commission that it must be very careful lest it lost the opportunity of securing to telephone users a cheaper rate than they were at present forced to pay. Mr. Johnson declared that the Commission was engaged in a most visionary pursuit in supposing that it was going to secure a reduction in the cost of the use of telephones. What the Commission had to do was to look after the interests of the ratepayers and take something in exchange from the companies which would benefit the payers of taxes The members of the Commission were appointed to watch the interests of the ratepayers, and not to study those of telephone users. The Chairman reminded the meeting that there was really nothing whatever before it on the subject which had been discussed. The matter then dropped.

Ealing.—It was reported to the District Council last week that through certain circumstances, including the illness of Mr. Harris, the engineers (Messrs Bramwell and Harris) had been unable to furnish the Council with a detailed statement of the expenditure in connection with the electric light installation, but that they hoped to be able to place that statement before the Council at the next meeting. The clerk stated that he had written to the Local Government Board requesting them to reconsider their decision not to sanction the issue of stock by the Ealing Local Board, and also asking the Board above to allow the issue of stock by that Council, but had received no reply to his communication. Mr. Baker Haye urged that the Council must, for financial reasons, promptly take some definite steps to raise, either by the issue of stock or otherwise, the sum (£25,000) authorised to be borrowed for electric lighting purposes, and any further sum which it might be found would be needed as a consequence of the extended electrical installations. The clerk was directed to again write to the

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Local Government Board, impressing upon them the necessity for an immediate reply to the question whether they would be prepared to reconsider the decision at which they arrived with respect to the application of the Board, and would be prepared to entertain an application by that Council for an issue of stock.

Telegraph Construction and Maintenance Company.—The report of the directors for the past year states that the accounts show a net profit of £91,921, after charging the interest on the debentures. To this sum must be added £51,228 brought forward from last year, making a total of £143,149. From this amount is deducted the interim dividend of 5 per cent., paid July 24 1894, amounting to £22,410, leaving £120,739 to be dealt with. Of this sum the directors propose to distribute a dividend of £1. 16s. per share, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2. 8s. per share, or 20 per cent., free of income tax, leaving £53,509 to be carried forward to the next account. The operations carried out during the year comprise the laying of a cable for the Eastern Extension Telegraph Company between Singapore, Labuan, and Hong Kong, and the manufacture of a cable for the Anglo-American Telegraph Company and its laying between Valentia and Newfoundland. Several lengths of cables have also been manufactured for different telegraph administrations and companies. Repairs of cables have been carried out in the North Sea and English Channel for the German Government. The transfer books are closed until the 26th inst, preparatory to the payment of dividend to all shareholders on the register on the 18th inst.

Underground Telephone Conductors.—The Highways Committee of the London County Council reported to that body last week as follows: "The Council on 19th June last gave permission to the National Telephone Company to construct a lateral passage from the Shaftesbury-avenue subway, at Macclesfield-street, for the purpose of conducting pipes from the subway to the new exchange station in Gerard-street, such permission being, however, subject to the following conditions: that the work shall be carried out in accordance with the plan submitted with the letter, dated 15th March, 1894, from the company's metropolitan manager, and under the supervision and to the satisfaction of the Council's chief engineer; that any damage that may be done in or about the subway during the execution of the work shall be made good by the company to the engineer's satisfaction; that the company do pay to the Council a rent of £50 a year for the accommodation, and do also provide, free of charge, additional direct connections between the exchange station and such two of the Council's offices as may hereafter be determined; and that the company do enter into an agreement to be prepared by the Council's solicitor, embodying the above conditions. This agreement has been prepared, and we recommend that the seal of the Council be affixed to the agreement above referred to with the National Telephone Company."

Southport.—The Works and Plan Sub Committee have reported to the Town Council that they had received a letter from Prof. Kennedy, in which he stated that the committee would be wise to extend the buildings on the general lines shown on the plan prepared by the borough surveyor. Councillor Hesford, in moving the adoption of the minutes, said that, on the advice of their engineer, an extended test had had to be abandoned Referring to the acceptance of a certain tender for the erection of a new chimney at Crowlands, he remarked that they had had the ground bored, so that for the distance of upwards of 20ft. they knew exactly what the substratum of the soil was. One hundred pitch-pine piles of 25ft. long and 12in. in diameter would be used Concrete would be added, and from this would be a superstructure of 192ft. Really, however, the chimney would be 130ft. They had received 13 tenders for the work, and the one accepted they asked the Council to pass that night. For the carrying out of the extensions to the boiler and engine house they had 18 tenders, which, after having been opened by the committee, were considered by a sub-committee, and they had made a careful selection. Councillor Todd seconded. After some discussion, the minutes were adopted, with the exception of that referring to the tender for boiler and engine house extensions, which was referred to the General Purposes Committee.

Lambeth, S.E.—A special meeting of the Vestry was held on Thursday of last week to consider the electric lighting question. Mr. John Williams submitted a motion requesting the Vestry to surrender the electric lighting order. The present position of the question was this: that they would have to "clear out" of the lighting order and let others come in, if they cared to do so, or go on with the scheme themselves. He was sure the Vestry did not want to take up the attitude of the "dog in the manger," and it was their duty if they could not see their way to adopt the electric light to stand aside and allow others to do so. Mr. Quick, who seconded, contended that the ratepayers had nothing to gain by allowing their Vestry to go in for any trading concern. The Vestry next received a deputation from the Lambeth Ratepayers' Association against the proposed scheme. A letter was received from Mr. S. Morse, on behalf of the County of London and Brush Provincial Electric Lighting Company, offering to take over the provisional order. The clerk (Mr. H. J. Smith) said Mr. Morse had called upon him, and had told him that his company intended to commence at once, and were perfectly ready to take over the Lambeth order, and to repay the Vestry the amount they expended in obtaining it. Mr. Akerman moved, as an amendment, that the Vestry proceed to the next business. This having been seconded, was put to the meeting and carried.

Coventry.—The Electric Light Committee of the Town Council have presented the following report: "According to the contract for the equipment of the electric lighting works, the supply mains are laid only on the east side of the street in Burges, Cross-cheaping, and Broadgate. This involves the trouble and expense of crossing the tramway line whenever it is necessary to connect a consumer on the west side. Your committee recommend that to avoid this a second supply main be laid on the west side of these streets, at the estimated cost of £203 5s. 9d. Your committee also recommend that a wall be built along the canal wharf at the works to enable coal to be stored there, at a cost not exceeding £30." The committee recommended in their minutes that the Liberal Club, distant 52 yards from the nearest main, be supplied with the electric light on the same terms as consumers within the 50 yards limit. Alderman Hill moved the adoption of the report, and said the recommendation about the new main was a question of economy. It would cost less to take the cable up the street than to be frequently running under the tram line. There was an estimate for carrying the cable to the bottom of Hertford-street in the same position, and possibly action might be taken on that, but at present the committee did not recommend it. Mr. West seconded the adoption of the report, saying it was the opinion of the engineer that if there were many installations of the light on the west side of Broadgate it would be cheaper to put a main in than to go on the alternate plan. The report was put to the meeting and adopted.

Windsor.—The Town Council had before them last week a motion by Mr. Dyson to the effect that steps should be taken to ascertain what amount of water power could be obtained from the Thames for the production of the electric light and electricity as a motive power. With papers before him he proceeded to argue the question that motive power could be obtained from the river for the supply of electricity, when Mr. Lovegrove pointed out that the Council had no power over the Thames, and Mr. Dewe asked what was the use of going into the question, having already taken the opinion of Mr. Shoolbred, their consulting engineer. Mr. Dyson replied that he presumed the Thames Conservancy were approachable, and if it was capable of being done surely the Council would not reject it merely because one gentleman had said it could not be done, because it had been done in other places. Mr. Bampfylde suggested that these matters could very well be brought before the committee, who could thrash out the question and bring something before the Council. Mr. Dyson replied that it was no use going before the Electric Lighting Committee because they had made up their minds, but he had certain facts he could lay before the Council. Mr. Soundy said if they were laid before the Electric Light Committee he would guarantee that they would be carefully considered. Mr. Dyson said he would accept the suggestion, and accordingly, on the motion of Mr. Soundy, seconded by Mr. Caley, the question of obtaining water power for the production of electricity was referred to the Electric Light Committee to consider and report.

Cardiff.—A meeting of the Court of Governors of the University College of South Wales and Monmouthshire has been held at the College, Cardiff, the Right Hon. Lord Aberdare being in the chair. Principal Jones informed the court that in the new engineering department great progress had been made, and two-thirds of the work were now completed. A testing-house and large workshop had been erected, but the boiler-house remained to be done. They were unable to proceed with this until the chemical laboratory was removed from the site over which the house was to extend. Greatly increased accommodation in the chemical laboratory would be required in the immediate future. The boiler was in place, a Willans steam-engine of from 35 h.p. to 40 h.p. had been erected, and this would drive the dynamo for the purpose of lighting the shops, and also the motor for the testing-house. The testing machine was the property of the Technical Instruction Committee, and had been purchased at a cost of £2,000. On Tuesday a meeting of the Lighting and Electrical Committee of the Cardiff Corporation was held, when the town clerk read a letter from Principal Viriamu Jones stating that the Technical Instruction Committee had appointed a deputation to wait on the Lighting Committee to lay before them the following points: (1) the feasibility of the utilisation of the new electrical works for the training of electrical engineers; (2) the advisability of the establishment of an electrical laboratory for the standardising of all electrical measuring instruments that may be in the town; and (3) the question of the improvement of the lighting outside the Stacey-road Hall. Alderman Jacobs asked how it was proposed to send the students. Principal Jones replied that it might be that from time to time the teacher would go to the officers and ask to be allowed to take in a class to see a certain thing; but what they chiefly desired was that the Corporation should make arrangements by which they could take in well-qualified students as apprentices for, say, three months at a time The borough engineer was instructed to report regarding the lighting at Stacey-road Hall, and it was decided to postpone consideration of the other matters until Councillor T. H. Riches was able to be present.

PROVISIONAL PATENTS, 1895.

FEBRUARY 11.

2965. **An improved process for the electro-deposition of aluminium and aluminium alloys.** Alfred Francis Bilderbeck Gomess, 9, Warwick-court, Gray's-inn, London.

2969. **Portable electric alarm attachable to either lever or pendulum clock or timepiece.** William Gardiner Grossett, 49, Dongola-road, Plaistow, London.

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2971. **Improvements in electrically-heated curling-irons.** Alfred William Armstrong, 85, Broadhurst-gardens, West Hampstead, London.

2998. **Improvements in and apparatus for the manufacture of copper, zinc, and other metal sheets, strips, or wires electrically.** The Cowper-Coles Galvanising Syndicate, Limited, and Sherard Osborn Cowper-Coles, 47, Lincoln's-inn-fields, London.

2999. **Improvements in and means to be employed for the obtainment of zinc from its ores, and the electro-deposition of zinc upon iron or other metals or alloys.** The Cowper-Coles Galvanising Syndicate, Limited, and Sherard Osborn Cowper-Coles, 47, Lincoln's-inn-fields, London.

3000. **Improvements in secondary batteries.** Camille Alphonse Faure, 47, Lincoln's-inn-fields, London.

3002. **Improvements in electric arc lamps for photographic purposes.** George Devey, 46, Lincoln's-inn-fields, London.

3003. **Improvements relating to the regulation of electric motors.** William Phillips Thompson, 31, High Holborn, London. (Emile Lauhoffer, Arthur Burghardt, and Jacques Burghardt, Germany.)

3006. **Improvements in electric arc lamps.** William Ernest Burnand, Norfolk House, Norfolk-street, London.

FEBRUARY 12.

3055. **Improvements in or connected with electric steering apparatus.** Frank King, 47, Lincoln's-inn-fields, London.

3062. **Improvements in electric locomotives.** Eben Moody Boynton, 52, Chancery-lane, London. (Complete specification.)

3066. **Improvements in means for preventing the liquid of primary and secondary batteries being spilt and for rendering it motionless, more especially during transport.** Edouard Henriquez, 70, Palace-chambers, Westminster.

3067. **Improvements in electrical storage batteries.** Edouard Henriquez, 70, Palace-chambers, Westminster.

3076. **Improved combined telephone and telegraph systems.** Henry Harris Lake, 45, Southampton buildings, Chancery-lane, London. (Christopher A. Shea and Freeborn Fairfield Raymond, United States.)

3081. **An improved ventilating-box cover for electric lighting culverts, or ways, sewers, cellars, or other places needing ventilation.** Albert Essinger and William Parrott, 26, Thavies-inn, Holborn, London.

3085. **Improvements in and relating to electric gas-lighting devices.** Jean Jahnsson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3086. **Improvements in automatic telegraph machines.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (World Flash Company, United States.) (Complete specification.)

3087. **An improved telephone system.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Christopher A. Shea and Freeborn Fairfield Raymond, United States.)

3095. **Improvements in and relating to electrical exchange systems.** George William Hey and Arthur Edward Parsons, 11, Southampton-buildings, Chancery-lane, London.

FEBRUARY 13.

3125. **Improvements in brackets for gas, oil, or electric light.** Charles Meason and Thomas Ford, St. Ives, Crompton-road, Handsworth, Birmingham.

3134. **Improvements in apparatus for indicating or recording telephonic connections.** Friedrich Wilhelm Heinrich Hempel and Alfred Maerker, 62, St. Vincent-street, Glasgow. (Complete specification.)

3172. **A method of ventilating the pipes, manholes, chambers, etc., containing the wires conveying electricity through streets and public ways.** Arthur Coke, 339, Oxford-street, London.

3178. **Improvements in and connected with testing and junction boxes, manholes, and culverts for electric light mains and other purposes and in the covers therefor.** William Macpherson, 11, Furnival-street, Holborn, London.

3179. **Improvements relating to electric light fittings.** Joseph Monteith, 6, Bream's-buildings, Chancery-lane, London.

3183. **Process for the production of concentrated sulphuric acid by means of electrolysis.** Leonhard Wacker, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

FEBRUARY 14.

3226. **An apparatus for steering steamships and other vessels automatically by the aid of electricity and the mariner's compass.** Frederick Edward Adams, 104, Park-road, Bolton.

3228. **Improvements in the ventilation and combined electrical and chemical purification of the atmosphere in open and closed spaces.** John Frick, 53, Chancery-lane, London.

3233. **A combination electric lamp and battery.** Thomas Edward Walter, 10, Basinghall-street, London.

3250. **Improvements in globes for electric glow lamps.** Victor de Spruner-Mertz and Joseph Koch, 28, Southampton-buildings, Chancery-lane, London.

FEBRUARY 15.

3331. **Improvements in or relating to electric arc lamps.** Frederic William Dickinson, 323, High Holborn, London.

3336. **Improvements in or connected with apparatus for electrically lighting miners' safety lamps.** William Ackroyd, William Best, and John Peel, 33, Chancery-lane, London.

3358. **Improvements in electric railway systems.** Malone Wheless, 47, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, 3rd December, 1894, being date of application in United States.) (Complete specification.)

FEBRUARY 16.

3386. **Improvements in electrical indicators applicable for various purposes.** Edwyn Grahame, 10, Basinghall-street, London.

SPECIFICATIONS PUBLISHED.

1893.

24274. **Electrolytic decomposition of metallic salts.** Kellner. (Reprints, with alterations.)

1894.

1491. **Arc lamps.** Barton. (Jandus.)

2274. **Supplying electricity to tramcars, vehicles, etc.** Pringle.

3079. **Electric bell indicator.** Sanders.

5647. **Secondary coils for transformers.** Schneller and Wisse.

5913. **Alternating-current generators.** Raworth.

6089. **Protecting electrical conductors.** Kingdon.

6912. **Electrical accumulators.** Hagen and Beyer.

9456. **Junction or fuse box for electric wires.** Russell.

13995. **Electric railways.** Thompson. (McLaughlin.) (Second edition.)

21127. **Arc lamps.** Day. (Schoeffel.)

25080. **Separating metals by electric action.** Oliver.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅝-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2⅝-2⅞
—— 4½ Debenture Stock	100	115-118
Charing Cross and Strand	5	5-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13½-14½
—— 6 per cent. Cumulative Pref.	10	15½-15⅝
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	46-48
—— 4 per cent. Debenture Stock	100	130-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	3-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	102-107
Electric Construction, Limited	2	½-½
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1½-1¾
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1½-1⅝
Elmore's French Company	2	1/16-3/16
Elmore's Wire Company	2	1½-1⅝
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	9½-10½
—— Preference	—	12
House-to-House Company, Ordinary	5	2½-2⅝
—— 7 per cent. Preference	5	6½-7
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	—	7-7½
Liverpool Electric Supply, Ordinary	5	7½-7⅝
—— Pref.	—	—
Liverpool Overhead Railway	10	8 9/16-8 11/16
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	½-⅝
Metropolitan Electric Supply	10	9⅜-10½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5½-5⅝
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7-7½
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7-7½
—— £24 shares	4½	5½-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7½-8
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	42-44
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7½-8
Yorkshire House-to-House	5	5½-5⅝

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NOTES.

New Book.—Mr. John Murray will shortly publish the second volume of Dr. Werner von Siemens's papers and addresses on scientific subjects.

Portable Lamps.—Portable electric lamps, it is reported, have been provided for the use of the bellringers at St. Edmund's Church, Salisbury.

Society of Arts.—On Tuesday next, at 8 p.m., a paper on "Colonies and Treaties," by Sir Charles M. Kennedy, K.C.M.G., C.B., will be read.

Definition of Reactance.—Mr. G. Giorgi has sent us a pamphlet on this subject, being an abstract of a contribution which appeared recently in *L'Elettricista*.

Electric Railway Bills.—The City and South London and the Great Northern Railway Bills were read a second time in the House of Commons on Monday.

Nice Electric Tramway.—A trial trip has been made on the electric tramway which has been constructed from Nice to Cimiez, and to which we have already referred.

Railway Rates.—The Board of Trade has extended for three months from the 22nd ult. the period within which complaints may be made regarding railway rates.

Electric Motors for Tree-felling.—According to the *Chronique Industrielle*, augers driven by small electric motors are being used in the forests of Galicia in connection with the felling of trees.

Electric Tramways in Europe.—Our contemporary *L'Industrie Electrique* has in course of preparation the third issue of its statistics of electric tramways and railways in operation on January 1, 1895.

Burmo-China Telegraph.—It is reported by the *Indian Engineer* that Mr. Jensen was to have completed his work at Momein in connection with the Burmo-China telegraph by the end of January.

Exhibition at Geneva.—There is to be held in Geneva next year an industrial exhibition in which a large section will be devoted to the applications of electricity. The exhibition will not be of an international nature.

Specialities for Watchmakers and Jewellers.—Messrs. Koch and Co., of Charterhouse-buildings, E.C., have forwarded us a copy of a catalogue illustrating the "Triumph" lathe and other specialities for watchmakers, jewellers, and opticians.

Economy.—Notwithstanding the fact that the inhabitants of Cardiff have been somewhat tardy in adopting the electric light, it is satisfactory to find that already some of those who have had their premises wired have found that electric light is cheaper than gas.

Students of the Institution.—A students' meeting of the Institution of Electrical Engineers will be held in the library of the Institution, 28, Victoria-street, on Friday next, the 8th inst., at 8 p.m. A paper on "Incandescent Lamp Manufacture," by Mr. Leonard Johnson, will be read.

Forthcoming Lecture.—A lecture on "Recent Developments in Electrical Science" will be delivered on Monday next, the 4th inst., by Mr. Fred H. Taylor, A.I.E.E., at the St. Andrew's Parish Room, Fairholt-road, Stoke Newington, N. The lecture will commence at 8 p.m.

Society of Engineers.—The next ordinary meeting of this society will be held at the Westminster Palace Hotel on Monday next, when a paper will be read on "Parliament Procedure as affecting Light Railways and Tramways," by Messrs. W. Worby Beaumont and Stephen Sellon.

Indian Telegraphs.—Very satisfactory progress is reported in the annual budget of the Indian Telegraph Department. It now shows signs of being more satisfactory than was anticipated. A new telegraph cable is to be laid between India and Ceylon in March, the old one which was put down in 1865 being abandoned.

Award.—The Bernhard Prize Commission of the French Chambre Syndicale des Industries Electriques have awarded the prize to M. Genet, who is employed by the Société Industrielle des Téléphones, whose works are situated in Rue du Théâtre, Paris. The *Bulletin International de l'Electricité*, from which this item is abstracted, does not mention the object of the award.

Personal.—Dr. Warburg, of the Freiburg (Baden) University, has been appointed professor in experimental physics at the Berlin University, in place of the late Dr. Kundt.—Mr. M. G. Ross having resigned his position as managing engineer to the Hastings and St. Leonards-on-Sea Electric Light Company, Mr. Leonard Andrews (who has had the charge of running the station for the past 16 months) has been appointed to take over his duties.

Douglas-Laxey Extension Line.—The late snowstorm has hindered the construction of the new railway from Laxey to Snaefell Mountain. Now, however, a numerous gang of men is engaged on the work, and the directors are endeavouring, if possible, to have the railway open for the summer visiting traffic. The line is to be worked on the overhead electric system, the same as on the present Douglas and Laxey electric tramway, in conjunction with which it will be run.

Indian Telegraph Department.—It is said that the mountain line of telegraph between Gilgit and Srinugger is undergoing a severe ordeal this winter, which has proved to be a keen one in Cashmere, being marked by tremendous snowstorms, which have at times lasted six days on end. The wire, the *Indian Engineer* states, has broken in several places, but the two repairing parties stationed between the Burzil and Traghal Passes sally out and do the necessary repairs whenever an opportunity offers.

Protection Against Lightning.—The Admiralty direct that in order that men working under a ship in dry dock may be secure against danger by lightning, a thorough metallic connection by wire rope, or otherwise, is to be effected between several points of the ship's iron, such as ring bolts, etc., and iron pipes leading to the water outside the dry dock, there being no danger to anyone or anything inside the ship. Similar precautions are to be taken in respect to the frames of ships on the stocks in the course of building.

Telephone Exchanges.—Mr. A. Morley, replying to Sir C. Cameron in the House of Commons on Friday, said that he had consulted the solicitor to the Post Office, and that he was advised by him that even if a corporation obtained the Postmaster-General's license to transmit telegrams by telephone, it could not erect and maintain telephonic apparatus and manage what was generally understood by exchange business at the expense or risk of the corporate funds or rates, without the express sanction of Parliament.

Portable Electric Light Plant.—A description is given in *L'Electricien* of February 23 of the portable plant now being introduced by the Maison Bréguet. The plant, briefly, comprises a vertical boiler, a Laval steam-turbine, and a Manchester type of dynamo, the combination being intended for the use of the army for search-light purposes. The boiler is constructed on the Trépardoux system, the use of which is claimed to allow of the rapid raising of

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pressure and of dry steam. The turbine and dynamo are coupled direct, and run at a high rate of speed.

Water Power in Scotland.—The attention of Sir George Trevelyan has been drawn to a project for utilising the famous Falls of Foyers, near Loch Ness, by using the water power to drive machinery for the generation of electrical energy. The project, as stated in our "Business Notes" last week, is entertained by a company which is about to start works for the extraction of aluminium. Sir George Trevelyan has instructed the local procurator-fiscal to enquire into the matter. It is proposed to bring the material from Ireland for the production of aluminium.

Telegraphy in Western Australia.—It is reported from Perth, under date of January 25, that an influential deputation has waited on the Minister of Public Works to complain of the great inconvenience and loss suffered by residents on account of the recent numerous delays and interruptions in the working of the telegraph lines in the colony, which, the deputation stated, had recently been in a terribly disorganised condition. This may be imagined when it is stated that the Press cables from England of January 19 appeared only in the newspapers of the 25th, and great indignation has been expressed in consequence. The Government is enquiring into the matter.

Systematic Teaching of Languages.—Those who are desirous of acquiring a perfect knowledge of both reading and conversing in foreign languages cannot do better than consult the pamphlet issued by the Central School Association, of Howard House, Arundel-street, Strand, W.C. Too little attention has been paid in the past to the most important point of conversational ability in other languages, and it is specially to drive home this weighty fact that the Central School was formed some two or three years ago. The great success of the school is due to the adoption of the "series" system of teaching, in conjunction with the use of mental visualisation and symbolic grammar. The history of the success of the school is given in the pamphlet, together with practical proofs of the satisfactory results obtained by those who have availed themselves of the benefits derived from attending the school.

New Swindon Junior Engineering Society.—A party of the members of this society travelled to Bristol on Saturday last for the purpose of paying visits to the Merchant Venturers' Technical College and the city electric lighting works. Arriving at the college at 3.30 p.m., they were conducted over the workshops and laboratories of this institution, which is under the control of Prof. J. Wertheimer, B.Sc., B.A. In the evening the party divided, one section proceeding to the electric lighting works at 6 p.m, the other making the visit at 11 p.m. This installation was found to be of exceptional interest, including as it does machinery of the most modern type. It was opened about two years ago, and has been supplying light to the city without a hitch since that time under the supervision of Mr. H. Faraday Proctor, to whom the society is indebted for permission to view it. The assistant engineer, Mr. R. W. L. Phillips, was most kind in his explanation of the switchboard and its instruments.

Laying of New Mains.—The Chelsea Electricity Supply Company desire to lay mains along the Chelsea-embankment and across the gardens there to the corner of Manor-street, and to construct draw-in and service boxes. It is proposed to lay the mains on the river side of the embankment, and consequently afterwards across the carriageway for the supply of the houses. The Highways Committee of the London County Council, however, think that some better arrangement should be made, and they therefore recommended on Tuesday that the Council should disapprove the works referred to. The Charing Cross and Strand Electricity Supply Corporation intend to lay mains on both sides of New-street, Covent Garden, and to construct two street boxes. The House-to-House Electric Light Supply Company want to lay mains in Evelyn-gardens and in Pembroke-gardens. Both high and low pressure mains are to be used. We wonder whether the present Highways Committee will be the Highways Committee next week, after the L.C.C. election. Let us wait until "the ball is over."

Metric System of Weights and Measures.—The Select Committee of the House of Commons appointed to enquire into the existing systems of weights and measures in this country, and whether any, and if so what, alterations are necessary, had a meeting on Tuesday under the presidency of Sir H. Roscoe. Evidence was given by Mr. H. J. Chaney, superintendent of the Standards Department of the Board of Trade, who described the system under which the verification of legal standards is carried on at the Board of Trade by experts appointed for the purpose, and also gave an account of the different systems of weights and measures now in use in the United Kingdom. He stated that the Imperial and the metric systems were the only ones with which the Department had to do in England, but there were other local customary weights and measures in use. Practically the only two countries of any importance in Europe in which the metric system was not adopted were Great Britain and Russia. In Germany, Austria, France, Italy, Spain, and Portugal the metric system was the only system in use.

Explosion at Euston.—An explosion in connection with the St. Pancras Vestry's electric installation took place at 7.50 p.m. on Saturday evening in Gee-street, Seymour-street, Euston-road, a few hundred yards from Endsleigh-gardens, where a similar explosion took place last December. As in the previous instance, the explosion was preceded by a low rumbling sound and directly afterwards the covers of two manholes, one in the roadway and the other on the pavement, were blown into the air, while the paving stones were dislodged for a space of four or five yards. The manholes are about 10 yards apart and are connected by culverts. The electric department of the Vestry and the Gaslight and Coke Company sent experts to make an examination. It is supposed that gas had accumulated in the manholes. Major Cardew has visited the place and will not hold an official enquiry, as the recommendations he made to the Department following the explosion in the Euston-road some few weeks ago were equally applicable to the present case. The Vestry are now engaged in making various alterations in accordance with Major Cardew's advice.

"Electric Measles."—Mr. George Anderson, in referring depreciatingly to the electric lighting of an Irish town, states that "we [the gas company] have got through the electric measles and still survive." Of course, that is due to living in Ireland. Everywhere, even in Ireland, this complaint is met with, and the worst of it is—for the gas companies at all events—that notwithstanding their endeavours to run down a successful competitor which is growing stronger every day, the electric light is becoming more popular and its use considerably extending. Mr. Anderson further says that "other corporations and other gas companies may have a touch of the disease." Of course they may, or, rather, they have already. It is truly unfortunate that a complaint of this dangerous nature should be permitted to develop in the alarming fashion prevailing at the present time, and we would suggest that Mr. Anderson should endeavour to induce the Board of Trade and Parliament to repeal the Electric Lighting Acts and the orders

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under which electric stations are conducted. Then this dangerous epidemic, like the influenza, will no longer be a menace to the gas companies.

Clark Cell when Producing a Current.—Experiments detailed in a paper by Mr. S. Skinner in the *Philosophical Magazine* were made with the object of ascertaining how far the total E.M.F. round the circuit differs from that of the open cell, in the case of a Clark cell which is being used to produce a current, and how far this new value for the E.M.F. changes when the current is maintained. The experiments were made on three cells, all much larger than the ordinary Board of Trade pattern of Clark cell. It was assumed that the total E.M.F. round the circuit is equal to that of the cell at rest, and therefore that the E.M.F. overcoming polarisation can be obtained by subtracting from the E.M.F. of the cells at rest the observed current. In this way it was found that (1) the E.M.F. of polarisation varies directly with the current density in a particular cell; (2) the E.M.F. of polarisation slowly increases when the current is maintained. From the magnitudes of the quantities found in the experiments, it follows that small currents of approximately known values can be obtained by the use of Clark cells of small internal resistance which may be neglected in comparison with the large external resistance.

New York "Electric Power."—Like the New York *Electrical Review*, as shown in these columns last week, *Electric Power* has been wool gathering. It prints in its monthly issue of February a letter from Mr. H. Ler complaining of the small amount of space which we devoted to a review of the "Proceedings of the International Electrical Congress held at Chicago." If Mr. Ler will again read the review in question he will find that it is of a congratulatory nature. But *Electric Power* editorially supports its correspondent, writing in the following ungrammatical and meaningless style: "Our correspondent in another column is prone to take offence to (*sic*) a *criticism* of our English contemporary, the *Electrical Engineer's*, 'review,' on account of his rather curt dismissal of the new congress book." If this is a specimen of the style of *Electric Power*, its readers may congratulate themselves that the editor and associate editor are able to inflict upon them in one month only five pages of editorial matter printed in large type, followed by a catalogue of the contents of contemporaneous electrical journals. "Prodeegious!" as Dominie Sampson would say. *Electric Power*, by the way, has gladly availed itself of our columns for information concerning electrical work on the European continent—but generally without any acknowledgement. We do not foster any ill-will towards *Electric Power*, which we hope to meet and shake hands with at the next clambake. Till then, dear friend—peruse a grammar.

Meter Testing Charges of the L.C.C.—The London County Council, as announced in these columns at the time, fixed on November 6 a scale of fees to be charged for the testing of meters at the electric meter testing station at Cranbourne-street. The Highways Committee consider, however, that it is necessary that, in addition, a scale of fees should be adopted for other services not included in the scale referred to. They accordingly recommended to the Council on Tuesday that, until further order, the undermentioned fees be charged for the services specified: "For testing each 'disputed' meter the charge shall be in accordance with the scale adopted by the Council on November 6, 1894, and no reduction shall be made if a number be sent in together. For taking a record of 'pressure' at any consumer's house within three miles of the testing station, such record extending over 24 hours, 10s. 6d. If such record extends over two consecutive periods of 24 hours, for such second period, 5s. For testing a single pair of service lines, 10s. In difficult cases (in addition to the fee of 10s.), for every hour or part of an hour occupied after the first two hours, 3s. 6d." These fees are to include omnibus fares for the inspector, but all other travelling expenses are to be charged in addition. It is a pity the Highways Committee did not recommend cab fares. It would have been so much better. Recent experience has shown the benefits (!) of travelling on the Council's business or lack of business, and the result of being on the "Hi, hi, hi, clear away there, for I'll drive by."

A Gassy Argument.—Mr. S. W. Durkin, the president of the Southern District Association of Gas Engineers and Managers, evidently possesses great inventive ability. This is the way he explained to members of that association in annual assembly last week the reason for the adoption of the electric light throughout the country: "I cannot pass on without giving a word of praise to the Welsbach system, and I trust the weak point in that system will become stronger. I know with us three instances in which electric light has had to give way in its favour. I notice some portion of the electrical Press bespatter this innovation in artificial lighting, so that the presumption is that it is appreciated by the public, and is not detrimental to health, as they would have us believe, and as recently published evidence testifies. There is no doubt that a large amount of capital is being spent on electric lighting. It is quite fashionable, you know; and, Britisher-like, when we do go in for a new thing we do not know where to stop, especially when other people have to pay for it. It seems to me that there is too much capital lying idle in this country, and that Providence has opened up a way to get rid of a portion of it at the expense of the poor ratepayer, who can stand any burden his rulers put upon him." The president forgot to mention the thousands of cases where gas has been removed and the electric light introduced in its place. As to the Welsbach light, its sickly green glare, which is so obnoxious and irritating to the eye, will greatly restrict the adoption of this light. Can Mr. Durkin mention a single instance where the introduction of the electric light has been a burden to the ratepayer? We think not; but what other argument could be expected from the gas side?

Measurement of Strong Electric Currents.—The members of the Vienna Physico-Chemical Society assembled on February 5 to hear a paper, by Dr. Johann Sahulke, dealing with exact measurements of electric currents. After referring to the method adopted by the English Board of Trade, the author described a new system in which there are used two balances similar in construction to those introduced in England. Two circuits are required. By the aid of an electro-dynamic balance, one of these is maintained at about one ampere, so that with one balance for a maximum of one ampere the satisfactory exactness of measurement can be obtained. In this circuit is arranged the fixed coil of a second balance, the movable coil of which lies in shunt to a resistance through which the main current to be measured is passed. This resistance is formed of manganin sheets in order to counteract the effect of heating. The fall in pressure obtained in this resistance can be regulated so that it amounts to about two volts, and consequently the movable coil—no matter how great the main current to be ascertained may be—is always exposed to the same pressure of about two volts, and is, therefore, always traversed by an equal current. As the fixed coil is also traversed by an approximately constant current, the apparatus works continuously in the direction of its highest sensibility. In

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this connection, the author stated that an exactitude of $\frac{1}{1000}$ can be attained. Whilst this method is specially intended for direct-current measurements, a similar system can be employed for alternating currents. In the latter case, the shunt to the manganin resistance is formed by the primary coil of a transformer having no iron, and having a ratio of transformation of 1 to 7. The secondary coil of the same gives the current which is led into the movable coil of the apparatus.

Does Electrocution Produce Instantaneous Death?—It was with a view to deciding whether execution by electricity, as practised in New York State, produces instantaneous, painless, and absolute death, that Messrs. A. E. Kennelly and Augustin H. Goelet, M.D., were deputed by the *Electrical World* of New York to be present at the execution of David Hampton, at Sing Sing prison, on January 28 last. It will be remembered that some observations by M. d'Arsonval led him to the conclusion that in electrical executions the death of the criminal was not produced by the passage of the current, but by the knife of the surgeon during the subsequent autopsy. On November 28 the *Electrical World*, in the desire to definitely settle this question, directed a letter to Governor Flower, of New York State, requesting that at the next electrical execution scientific witnesses should be selected whose duty should be to make such observations as would throw light upon the matter. This recommendation was favourably received, and Messrs. Kennelly and Goelet were appointed to perform this duty on the occasion of the twenty-fourth electrical execution in New York State. As a result of their observations, the writers conclude as follows: "The evidence is that a current of eight amperes, applied through the body at a pressure of 1,740 volts, and representing a power of (1,740 × 8 =) 13,920 watts, or about 18⅔ e.h.p., will produce instantaneous, painless, and absolute death; and that the evidence presented by an examination of the brain alone was sufficient to demonstrate the absolute impossibility of resuscitation. Although in our opinion there is no hope of resuscitation in cases where, as in this electrical execution, an alternating current of sufficient E.M.F. is deliberately sent through the body of the criminal, yet in all cases of accidental contact with high-pressure circuits, in our opinion, efforts for resuscitation should be made, since in most cases of accidents from electricity, either from the imperfection of the contact or its short duration, the current strength passing through the body and the electrical energy expended thereby might only be sufficient to produce a loss of consciousness."

A Theory of the Causes of Explosions.—Mr. Arthur Shippey has now come forward with a theory of the cause of explosions in connection with underground mains. The following note on the subject is culled from last week's *Gas World*, although we are under the impression that it appeared a few days previously in the *Pall Mall Gazette*. Let Mr. Shippey speak for himself: "My theory is that many of the explosions which have taken place, both here and on the Continent during the past ten years, have been caused by lightning flashes conveyed to the earth through lightning conductors, which need not—in order to cause an explosion—be fitted in the immediate vicinity. These atmospheric lightning waves are known to travel underground for miles, until they reach, or are absorbed by, water or damp earth, both of which have a great affinity for electricity. Then, again, it must not be forgotten that our principal thoroughfares, in which the electric mains are laid, are composed of a compound substance of a semi-metallic nature, consisting of earth and pulverised metals, brought into existence by reason of the wear and tear of thousands upon thousands of tons of iron tyres, carriage wheels, horseshoes, and other pulverised metallic substances. In this compressed compound there is laid a network of gas, water, and bare copper electric mains, a combination which forms an absolute and complete passage for the conveyance of the flashing currents. I base my theory on the fact that many explosions have occurred in districts where thunder and lightning have been hovering about in the vicinity, hence I am convinced that this is one of the real causes which has brought about the actual firing of explosive mixtures, which are allowed to accumulate in the culverts and manholes of some systems. I may just say that I think I have hit upon a plan which will entirely overcome the whole difficulty, but I must refrain for the present from divulging it. I think Sir David Salomons's suggestion [made in the *Electrical Engineer* a few weeks ago], to fill up the open spaces with sand-bags, to prevent accumulation of explosive gas, is a very good idea, and his plan should be thoroughly tried."

Low Temperatures and the Attractive Power of Magnets.—A communication was made to the French Académie des Sciences on February 4 by M. Raoul Pictet on the "Influence of Low Temperatures on the Attractive Power of Artificial Permanent Magnets." The author stated that the experiments referred to were made with a magnet weighing 493·5 grammes, and formed of three elements in horseshoe iron. After magnetisation, the magnet was made to carry its charged armature for two years. It could then sustain 4,275 grammes. It was subsequently left for 11 months without armature, and then could only bear 3,226·5 grammes. The magnet was then placed in a small frigorific vessel filled with pure alcohol; it was arranged vertically with the poles or branches in the air, and stayed with pieces of wood. The alcohol in which the magnet was placed was caused to touch the surface of a glass 3mm. thickness placed horizontally upon the branches. Two thermometers indicated the temperature of the alcohol, maintained constant by an agitator. The armature of the magnet in contact with the upper surface of the glass was fixed to the plate of a sensitive balance. It could only rise one-fifth of a millimetre, and was retained by two points closing an electric current which passed through a galvanometer. The following table gives the averages of the results obtained by four series of observations, in which the differences were always less than 1·50 grammes:

Temperature of the magnet. Degrees.	Power of magnetic attraction. Grammes.	Temperature of the magnet. Degrees.	Power of magnetic attraction. Grammes.
+ 30	57·31	− 40	66·70
+ 25	57·87	− 45	67·41
+ 20	58·48	− 50	68·45
+ 15	59·10	− 55	68·91
+ 10	59 81	− 60	69 64
+ 5	60·36	− 65	70 30
+ 0	61·04	− 70	71·12
− 5	61·80	− 75	71·98
− 10	62·42	− 80	72·70
− 15	63 42	− 85	73·41
− 20	63·93	− 90	74·18
− 25	64·60	− 95	74·95
− 30	65 35	− 100	75 80
− 35	66·09	− 105	76·64

The Government and Telephony.—Mr. H. Foster on Tuesday asked the Postmaster-General whether he was aware of a memorial or statement issued by the Corporations of Edinburgh, Glasgow, and Aberdeen urging that he should grant telephone licenses to municipal authorities, and protesting against the creation of a gigantic private

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monopoly being conferred upon the National Telephone Company; whether this protest was supported by almost every municipal corporation in Great Britain; whether the negotiations referred to by the Chancellor of the Exchequer a few days since were with the municipal authorities; and whether he was able to state the present position of those negotiations. Mr. A. Morley replied: I have received memorials from the Corporations of Glasgow, Aberdeen, and other towns in Scotland, urging that the Government should itself assume the working of the telephones, or that licenses should be granted to municipal authorities. I have also received a deputation, representing the corporations of Edinburgh, Glasgow, and Aberdeen, in support of those views, and objecting to the monopoly of the National Telephone Company. But I have not received any protest in writing from Scottish corporations or from municipal corporations in Great Britain such as that referred to by the hon. member. The negotiations referred to by the Chancellor of the Exchequer simply had reference to an arrangement for discussing the telephone question prior to the agreement with the telephone company being signed, and this opportunity for discussion will, I hope, be afforded on Friday next, on the motion of the hon. member for the St. George's Division of the Tower Hamlets." The following is the text of Mr. Benn's motion respecting telephone licenses, which has the first place at the evening sitting to-day (Friday): "That a Select Committee be appointed to consider the proposed draft agreement between the Postmaster-General and the National Telephone Company, and report with reference to the monopoly which may thereby be created; the granting of telephone licenses to municipalities; and generally on the future policy of the Post Office with reference to the extension of the telephone service." At a meeting of Scotch members held in one of the committee-rooms of the House of Commons on Wednesday, Sir C. Cameron presiding, it was agreed to support this resolution, and an interesting debate is anticipated.

Investigation of a Rotary Field.—In the course of a mathematical article published in the *Elektrotechnische Zeitschrift* of February 21, on the "Investigation of a Rotary Field," Mr. O. S. Bragstad states, in connection with the necessity for special knowledge of the properties of rotary-current motors, that very little valuable information is available on the subject. The author has therefore endeavoured to throw some light upon the matter, his paper being confined to a method of investigating rotary-current motors. The measurements were carried out with an old two-phase motor having eight pole-pieces and a "perforated" armature with a short-circuited drum winding. The most important dimensions of the motor are as follow:

Circumference of armature	62	centimetres.
Length of armature	15·5	,,
Length of pole-pieces (parallel to the shaft)	16·5	,,
Width of pole-pieces	3·7	,,
Height (radial) of pole-pieces	2·3	,,
Radial height of the armature iron	3·9	,,

The experiments were confined to measurements with a continuous current and with a revolving armature. As a result of the investigation, the author stated that on light running, to which the measurements related, currents upon which a positive turning moment is exercised exist almost only between two pole-pieces. The latter is in a great part compensated by means of a counter turning moment in the points of strongest induction. The resulting armature currents cause a lot of work on light running, and bring about injurious heating of the armature. With a load the currents are in front of the pole-pieces, and even if they are not negative in consequence of the small armature speed they are very weak, whilst the strongest currents between the pole-pieces in relation to the production of circumferential power, are badly utilised on account of the there existing weak magnetic induction. The author concludes, therefore, that endeavours should be made to obtain the strongest currents where the normal component of magnetic induction is the strongest. The efforts of practice in the direction of constant "speed of field" lead to this object, and they are justified in so doing. The degree to which the object can be attained must be ascertained by measurements with modern machines. In previous experiments made under similar conditions it was found that the efficiency of the motor at a performance of 234 watts was 17 per cent., the work on running light requiring 1,000 watts.

Electric Lifts.—The fatal accident which took place a few days ago in the City in the working of a lift brings forward once more the question of substituting electric lifts for those operated by hydraulic power and other means. In this connection the New York *Electrical Engineer*, in discussing the passing of the hydraulic elevator, makes some pertinent remarks. Our contemporary says: For ordinary buildings of a few storeys in height, many hundreds of electric elevators have already proved their value, and some idea of the extent of this work may be gathered from the statement that in New York City alone there are connected to the Edison service mains no fewer than 250 elevators, aggregating 3,000 h.p. This class of electric elevator service presented no particular difficulties in the past, but the high-duty service requisite in buildings ranging anywhere between 10 and 25 storeys presented a problem which even the boldest of electrical engineers have shrunk from attempting until within quite a recent period. Indeed, it took the courage of conviction and the electrical skill of Mr. Frank J. Sprague, aided by the mechanical ingenuity of Mr. Chas. R. Pratt, to bring the electric elevator to a point where it could successfully compete with the high-duty hydraulic elevator. The great Parrot Building, San Francisco, is now being equipped with no fewer than 15 Sprague-Pratt elevators, and this must be considered conclusive evidence of the fact that the electric elevator has come to be recognised as the standard high-duty elevator of the world. The continued experience with the Sprague-Pratt elevators in the Postal Telegraph Building in New York more than confirms the estimate put upon them, and while we do not suppose that hydraulic elevator building will cease at once, we are convinced that the days of the hydraulic elevator as the standard are numbered. While the experience of the Postal Telegraph Building and of other buildings with other types has already proved the economy of such elevator service, it might be well to emphasise the fact, or point, that an ideal condition of affairs could be realised in electric elevator service by the introduction of storage batteries. The service, being highly intermittent in character, presents the best conditions for economical working in connection with storage. But there is another immense superiority over the hydraulic elevator. In the case of the latter, the storage tank under the best conditions would probably be able to afford scarcely half-a-dozen trips after the shutting down of the pumps, whereas a storage battery, occupying the same space as the water-tank of the hydraulic elevator, would store perhaps twenty times the energy contained in the stored water, or, in other words, allow of over a hundred elevator trips. Besides this, there would be an additional advantage in the decreased size and cost of the steam and electric plant, due to its operating at maximum power at all times independent of the elevator load.

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WATERLOO AND CITY ELECTRIC RAILWAY.

The directors of the South-Western Railway have long felt that the situation of Waterloo Station placed them at a considerable disadvantage, as compared with lines having a terminus north of the Thames, and the various proposals for getting over this difficulty were discussed years ago. When the City and South London Railway became an accomplished fact, it was at once seen that there were many other places in which the same system could be advantageously applied. The use of electric traction reduced the ventilation required to a minimum, whilst the expense of construction could be materially decreased by keeping the tunnel at a depth below the sewers or the foundations of existing buildings. Amongst others, the directors of the South-Western Railway decided that by adopting the Greathead system it would be possible to run a line from their terminus to the City at a cost likely to make the outlay remunerative, and accordingly the Waterloo and City Railway Company was constituted. This, though a separate company, has the same directors as the South-Western, of which it will practically form a branch or feeder. The line will commence under Waterloo Station, where the rail level will be 36ft. below that of the South-Western Railway, and will finish in Queen Victoria-street, between Queen-street and Bucklersbury, close to the Mansion House, and consequently to the Bank of England and the Royal Exchange. The rail level here will be 65ft. below that of the thoroughfare, and hydraulic lifts will be provided, but at the other end this has not been considered necessary, especially as the electric station will have to be connected with the various platforms. There will be no intermediate station, and it is expected that the time occupied in the journey will be about four minutes. As the distance is a little over a mile and a half, this will give an average speed of 22 miles an hour. Like the City and South London, the up and down lines will be in separate tunnels. These tunnels will not necessarily, nor even usually, be on the same level, nor will they always be the same distance apart. As a rule, there will be about 4ft. between the outsides of the tubes, but in some parts they will be brought much closer together, so as to keep both lines as much as possible under existing roadways. The steepest incline will be 1 in 30, which will be the gradient at which the line from Waterloo to the City will leave the former station, so that it will be with the load. The steepest against the load will be 1 in 60, which will be the incline at which the other line will enter Waterloo.

The engineers for this company are Messrs. Galbraith and Greathead; Mr. H. H. Dalrymple Hay, A.M.I.C.E., being the resident engineer. The contract for the construction of the tunnels from Cross-street, near Waterloo Station, to the City, and for the City terminus, has been let to Messrs. John Mowlem and Co., who are represented on the site by Mr. W. Rowell. The contract was signed last June, and in July the contractors commenced driving the piles for a stage which they have put up in the Thames, just above Blackfriars Bridge. This stage is close to the Surrey shore, to which it is connected by a gangway leading to it from Upper Ground-street. As soon as it was completed two iron cylinders were sunk from it into the bed of the river, entering the clay to a depth of 13ft. When the contents of these cylinders had been excavated the shafts were continued and were lined with brickwork, the first 10ft. of this being 1ft. 6in. thick, followed by 17ft. of 2ft. 3in. thick, which reached to the bottom of the tunnels. The upper part of the brickwork is circular, like the cylinder, but its section is gradually changed, so that at the bottom the shafts have two flat sides at right angles to the axis of the tunnels, the section being very nearly a square with rounded ends. This part of the work was completed last October, and the shields for the four headings were then lowered in pieces and put together at the bottom of the shafts. A temporary doorway connects the bottom of the two shafts, but there will be no further connection between the up and down tunnels until they meet at Waterloo or the City. The soil at the bottom of the shafts was found to be blue London clay, and up to the present the nature of the ground has not varied; so that there has been absolutely no infiltration of water, and therefore no necessity to use compressed air. But by the end of March the headings towards Waterloo will have risen sufficiently to penetrate into ground which borings have shown to consist chiefly of ballast. Here it is expected that water will be encountered in considerable quantities, and consequently it will be necessary to excavate under pressure. Preparations have been made for this; the air-locks are ready to be put up when required, and a fine pair of air-compressors, by Messrs. Markham and Co., Limited, of Chesterfield, are on the stage, ready to be started. The cast-iron tubes, which are being made by Messrs. Head, Wrightson, and Co., Limited, are in sections 20in. long, each section consisting of seven segments and a key-piece at the top. All joints are planed and are radial to the centre of the tunnel, excepting the sides of the key-pieces, which are parallel, so that they may be inserted more easily. The segments are joined together, and the separate sections of the tube are also connected, by means of turned bolts, 1in. diameter. There is no packing between the segments, but a thin wooden packing between each ring. Going from the starting point towards the City, the tubes are 12ft. 1¾in. internal diameter and 13ft. external; but towards Waterloo, where there are several sharp curves (one of which, five chains radius, is already completed), the diameters are 12ft. 9in. internal and 13ft. 7¼in. external. The increased size has been necessary to prevent the carriages from fouling the sides when going round curves.

The shields used for excavating are similar to those employed on the City and South London Railway. They are pushed forward by eight hydraulic jacks, pressing against packings which bear on the finished part of the tube, and spaced at equal distances round its circumference. By working some of the hydraulic jacks and stopping the others, the direction of the shield can be varied as may be desired. An advance heading, strongly timbered, is kept a few feet in front of the shield; and the excavation is done entirely by means of pick and shovel. The soil dug out is loaded at once into skips, which stand on a low-platform truck running on rails 20in. gauge. At present these are pushed by hand to the shaft, where they are hoisted by a steam crane and emptied into barges. Later on, the haulage will be done by electric locomotives: one of these, by Messrs. Siemens Bros., has just been delivered on the works. The work is carried on by day and night gangs, but stops altogether on Sundays. The maximum advance in the 24 hours has been 10ft. On February 21, 390ft. of the up tunnel had been constructed towards Waterloo, and 500ft. towards the City. The down tunnel extended 80ft. towards Waterloo and 200ft. towards the City. As a test of accuracy, boreholes are being put down, both on the Middlesex and Surrey sides of the river, so that the line may be plummed from the surface; but it is not proposed to make openings for any other purpose until the ends of the line are reached. As each segment is put together inside the shield, before the latter is moved forward, an annular space of about ¼in. is left between the outside of the tube and the surrounding ground. This is filled with a grouting composed of blue lias lime and sand. A hole is left in the centre of each segment into which a hose is inserted, leading from an iron vessel, called a "bougie." The lime and sand are mixed in this with water; and then, whilst a handle is continually turned to keep the mixture homogeneous, air, at a pressure of 20lb. to the square inch, is admitted, and the grouting is forced through the hose into the vacant space. At the stations, the two tubes will be united in one, also of cast iron, and 23ft. internal diameter.

The line, after leaving Cross-street, passes under the Waterloo-road and along Stamford-street to Hatfield-street. Here there are several rather sharp curves, to avoid private property as much as possible, and then the river is reached. On the north side of the Thames it will pass under the District Railway, where the rails will be 53ft. below those of the existing line. Another curve brings it under Queen Victoria-street, and its centre line will

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practically coincide with that of the street till the terminus is reached. During part of its course up this street (from St. Andrew's-hill to Friday-street) its centre line will also be exactly under that of the District Railway, the difference between the rail levels being 45ft. to 53ft. The dynamos and electric lighting plant used in the tunnels are by Messrs. Paterson and Cooper, of Victoria-street. It is expected that the line will be opened to the public during the latter part of next year. The details of the permanent electric system have not yet been settled, as the engineers consider it premature to do this until the tunnels are further advanced.

CITY AND GUILDS OF LONDON INSTITUTE.

We have received a copy of the report of the results of the work done at this institution during the year or session 1893 94. An abstract is given below: For two years there has been a decrease, not large, but still not unimportant, in the number of candidates at the entrance examination. One cause is the great increase of facilities for obtaining technical education in London and in the provinces since the college opened. Probably, however, the falling off in the number of candidates for admission this year is chiefly due to the continued commercial depression. The Siemens memorial scholarship, which is offered every third year, was awarded to Mr. F. Twyman, who has been educated at the City and Guilds Technical College, Finsbury. The diploma of associate of the institute (A.C.G.I.) is granted to students who have followed one of the three prescribed courses, including instruction in all four departments (mathematics, engineering, physics, and chemistry), and who have passed the sessional examinations with credit. This year, 46 matriculated third-year students were examined, and 30 were recommended for the diploma of associate of the institute. The highest place in the class list was taken by Mr. F. Maeers, a student of the engineering department. Mr. Maeers was educated at St. Dunstan's College, and obtained the Siemens scholarship at the matriculation examination in 1891; at the end of his second year's course he was awarded the John Samuel scholarship. Mr. H. C. Leake, the John Samuel scholar of last year, who received a diploma in civil and mechanical engineering, re-entered the college in the department of electrical engineering, and this year has taken a diploma in electrical engineering. Hitherto, one Siemens medal has been annually awarded in the physical department, usually to the student who did best in the third year of the course. This year Lady Siemens has graciously given consent to the annual award of two Siemens medals—one in the department of civil and mechanical engineering, and one, as before, in the department of electrical engineering. These medals have been awarded to Mr. F. Maeers in the engineering department, and to Mr. H. C. Leake in the physics department. The plan of awarding a works scholarship to meritorious students of moderate means, to help them to enter works where they would obtain good practical experience, was first tried last year. This year the engineering premium was awarded to Mr. F. Maeers, who has become a member of the private staff of Mr. L. J. Seymour, the managing director of the works of Messrs. Fraser and Chalmers, at Erith. A fellowship has been conferred by the council of the institute on Dr. W. E. Sumpner. A table given in the report affords such particulars as are known of the career, after leaving the college, of those students who have followed a regular course of instruction and who have gained a diploma. Most of the students who left the college in July have obtained employment with remuneration, or as improvers with small wages, or as pupils by paying a premium. In the physical department, Dr. Sumpner, who left the institute's service to take an appointment as head of the electrical department of the Battersea Polytechnic, and who has recently been appointed principal of the Birmingham Municipal School, has been replaced by Mr. W. G. Rhodes. Mr. P. G. Ledger, who held the position of assistant demonstrator, has been replaced by Mr. A. H. Allen.

PORTABLE TELEPHONE APPARATUS.

Attention has been directed for a good many years, successfully in many cases, to the construction of apparatus which allow of simultaneous and independent signals being transmitted over the same wire. It is of importance to be able to use a telegraph wire for telephonic communications without disturbing the Morse signals. For this purpose, Mr. J. Berliner, of Hanover, has invented a portable telephone apparatus, which is being used in connection with stationary appliances in Germany and elsewhere. The portable arrangement comprises a Ruhmkorff induction coil, for calling up with automatic interruption; a micro-telephone with universal transmitter and automatic switch; a box telephone; an automatic switch for switching off the battery; a wire condenser; a push button, with one non-working and two working contacts; four dry cells; three connecting terminals for the line and earth; 20ft. of double cable with four connecting plugs; and one terminal for the earth connection by screwing to a rail. The apparatus is carried in an oak box, the whole weighing 15lb. The arrangement is intended to be used in connection with telegraph wires on open tracks, in order that conversation can be had with the next railway station. For Fig. 1, which shows the apparatus, and Fig. 2, a diagram, we are indebted to the *Elektrotechnischer Anzeiger* of Berlin. The method of operation is as follows: A jointed rod is put together and hooked on a wire connecting with the next station's fixed apparatus. The plug connected with the rod is inserted in the plughole L in the diagram. A connection is then made between the plughole E and a railway rail. In case the wire in question is not being used for telegraphic transmission, the plug connected with earth (the rail), is pushed into the plughole Y. This switches out the condenser, and in consequence audibility

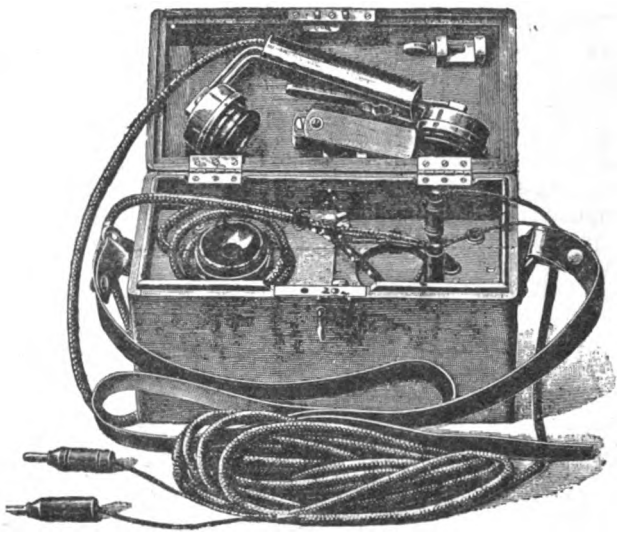

Fig. 1.

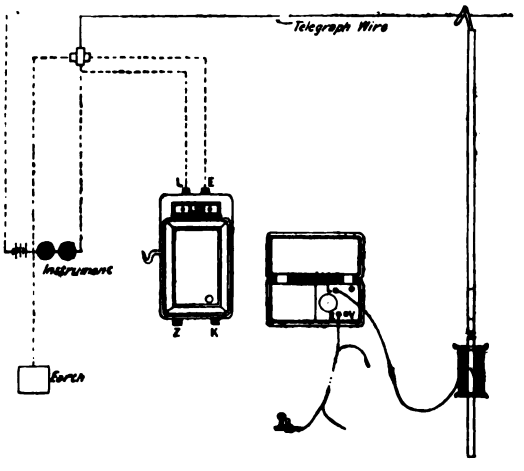

Fig. 2.

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will be increased. The telephone is next taken out of its case, which causes the battery to be switched in. The signal is given by pressing the button, which causes a loud buzzing in the telephones of the station called up. The reply signal having been received conversation can take place. During conversation the switch in the handle of the micro-telephone must be pressed.

EFFECT OF ARMATURE CURRENT ON MAGNETIC LEAKAGE.

This subject is discussed by Messrs. H. D. Frisbee and Alex. Stratton in their graduation thesis in electrical engineering, Columbia College. The following is an abstract:

Several investigations have been recorded, which have had for their object to determine the extent and distribution of magnetic leakage in dynamos and motors, and many formulas have been deduced from a theoretical standpoint, to predict the magnitude of the stray field of a machine from its dimensions. But up to the present time very little notice has been taken of the fact that the current in the armature usually has considerable effect on the magnetic leakage of a machine, and, therefore, the present experiments were made with the object of determining the nature and amount of this influence. With this end in view, four machines were chosen, representing widely different types: (1) Crocker-Wheeler 5-h.p. motor (over type); (2) Crocker-Wheeler 5-h.p. compound dynamo (over type); (3) 1½-kilowatt Edison shunt dynamo (under type, or horseshoe type); (4) 2 h.p. Sprague motor (consequent pole, or Manchester type). The two 5-h.p. machines were exactly alike in their frames and armatures, the only difference being in the winding of the field coils. This gave an excellent opportunity to make a comparison between the effect of armature reaction when opposed to a shunt field and when opposed to a compound field.

The general conclusions arrived at by the writers are as follow:

A careful consideration of the machines shows that similar actions take place in all the types, the difference being principally in degree. The following points are of interest:

(1) The change of flux in the pole-pieces when current was passed through the armature caused increased induction in one pole-piece and corresponding decrease of induction in the other, this being the case even with the compound-wound machine.

(2) The magnetic effect of the armature current is more marked in machines which have (*a*) armatures of large diameter; (*b*) ring winding.

(3) With a large air-gap, as in smooth-core armatures, the coefficient of leakage is very large, but this coefficient is less affected by armature reaction. Conversely, with small air-gap, as in toothed armatures, the coefficient of leakage is small, but this coefficient is more affected by armature reaction. Freedom from armature reaction means large increase in the ampere-turns on the field.

(4) With proper construction of the pole-pieces, armature reaction is not such a thing to be dreaded—that is, if the air-gap provides ample space for the shifting of the lines of force consequent on loading the machine, the armature reaction does not cause marked trouble. Indeed, this same armature reaction can be made to keep the speed of a motor constant under all loads, or the motor can even be made to increase its speed with the load. In short, the advantages of differential winding can be obtained in a simpler way, and without the danger of entirely destroying or even reversing the field magnetism when the motor is overloaded.

This may be inferred from the fact that the 5-h.p. C.-W. motor before mentioned was made to increase its speed considerably at full load by inserting resistance in the field winding, thus weakening the magnet. The same action would undoubtedly take place if the pole-pieces were so shaped as to partially throttle the lines of force when the field was distorted by armature reaction.

POWDERED LEAD ACCUMULATORS.

The Compagnie Française pour la Pulverisation des Metaux have taken up the manufacture of secondary batteries based upon the use as active material of pure and very fine lead powder, which is obtained by a mechanical process, and which is subsequently mixed with a very porous inert material. The plates serving as electrodes are provided with this active material. These plates, one of which is shown in Fig. 1, are formed of "ribbons" of lead, having furrows formed dove-tail fashion. According to the makers, the employment of pure lead has a great advantage over the oxides of lead ordinarily used, as the active material thus obtained, forming

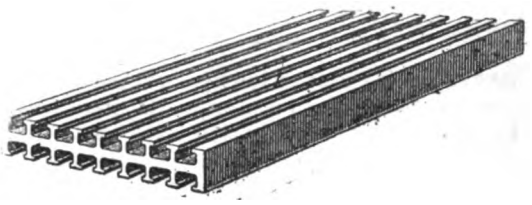

FIG. 1.

a common body with its support, the contact between the two is perfect from an electrical point of view. Moreover, the mixture of lead powder and the inert material constituting a compound having a great degree of porosity, the electrolyte is able to better penetrate the mass, and consequently the chemical work is much more complete, the result being a very high capacity and efficiency. Another advantage claimed for this type of plate is the obviation of the disintegration of the plates. The makers produce two types of cells. The first is arranged in a glass case for capacities varying from 32 to 500 ampere-hours; the weight of the complete cell ranges from 12 to 67 kilogrammes.

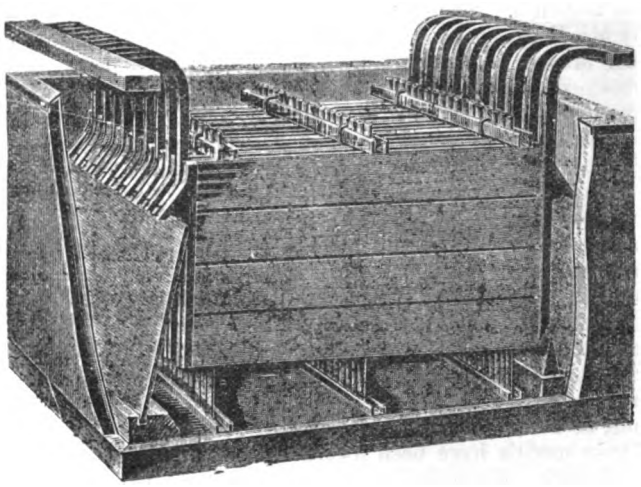

FIG. 2.

The second type, which is represented in Fig. 2, contains electrodes placed in lead-sheathed wooden boxes. The cells of this type are constructed for capacities varying from 336 to 2,640 ampere-hours; the weight of one complete cell of the smallest form is 91 kilogrammes, and of the heaviest, 363 kilogrammes.

In the fitting of these cells, each plate, according to the capacity to be obtained, is formed with the assistance of a variable number of standard or unit plates of the same dimensions. The latter are soldered in a lead frame, which carries on each side an iron projection allowing of the suspension of each electrode from two insulating supports, usually of glass, and arranged inside the case or box. The distance between the electrodes is maintained invariable by means of glass tubes placed vertically and resting at their lower ends in a furrow made at the bottom of the case, whilst their upper ends are held between two glass rules. All the connections are made by soldering. The electrolyte used is water acidulated by pure sulphuric acid of a density of 1·20deg. or 24deg. Baumé.

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As stated by the makers, the capacity of a cell of the first type, weighing 36 kilogrammes, and being 25 centimetres long, 33 centimetres wide, and 38 centimetres deep, is as follows:

	Rate of discharge in amperes.	Capacity in ampere-hours.
Discharge in four hours.....	40	160
Discharge in five hours	35	175
Discharge in six hours	31·7	190
Discharge in eight hours	28·1	225
Discharge in ten hours	25·0	250

The average E.M.F. of the cell, with a cell having a five hours' discharge, is 1·93 volts. The discharge should normally be stopped at 1·85 volts, although it can be continued without injury to a lower figure. These accumulators can be discharged in less than four hours, and in this case the final voltage can be allowed to fall to 1·80 volts. The makers guarantee the cells for two years, and they will undertake for 10 years the maintenance of the accumulators on the annual payment of from 4 to 10 per cent. of the purchase price.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

PART III.—DIMENSIONING OF FIELD-MAGNET FRAME.

1.—General Construction Rules.

(41) *Forms of Field Magnets.*—With reference to the type of the field-magnet frame, modern dynamos may be classified as follows:

I.—Bipolar Machines.

(1) Single-horseshoe type—(*a*) upright single-horseshoe type (Fig. 67); (*b*) inverted single horseshoe type (Fig. 68); (*c*) horizontal single-horseshoe type (Fig. 69); (*d*) vertical single-horseshoe type (Fig. 70).

(2) Single-magnet type—(*a*) horizontal single-magnet type (Figs. 71 and 72); (*b*) vertical single-magnet type (Fig. 73); (*c*) single-magnet ring type (Fig. 74).

(3) Double-magnet type—(*a*) horizontal double-magnet type (Figs. 75 and 77); (*b*) vertical double-magnet type (Figs. 76 and 79); (*c*) inclined double-magnet type (Fig. 78); (*d*) double-magnet ring type (Fig. 80).

(4) Double-horseshoe type—(*a*) horizontal double-horseshoe type (Fig. 81); (*b*) vertical double-horseshoe type (Fig. 82).

(5) Iron-clad type—(*a*) horizontal iron-clad type (Figs. 83 and 84); (*b*) vertical iron-clad type; single-magnet vertical iron-clad type (Figs. 85 and 86); double-magnet vertical iron-clad type (Fig. 87).

II.—Multipolar Machines.

(1) Radial multipolar type—(*a*) radial outer-pole type (Fig. 88); (*b*) radial inner-pole type (Fig. 89).

(2) Tangential multipolar type—(*a*) tangential outer-pole type (Fig. 90); (*b*) tangential inner-pole type (Fig. 91).

(3) Axial multipolar type (Fig. 92).

(4) Radi-tangent multipolar type (Fig. 93).

(5) Single-magnet multipolar type—(*a*) axial pole single-magnet M.P. type (Fig. 94); (*b*) outer inner-pole magnet M.P. type (Fig. 95).

(6) Double-magnet multipolar type (Fig. 96).

(7) Multipolar iron-clad type (Fig. 97). Horizontal four-polar iron-clad type (Figs. 98 and 100).

(8) Multiple-horseshoe type (Figs. 101 and 102).

(9) Quadruple-magnet type (Fig. 103).

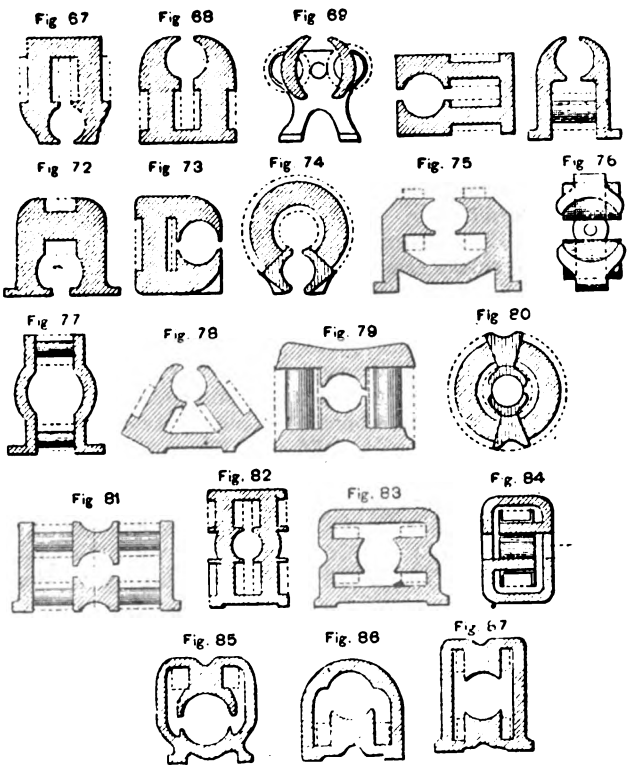
(10) Four-polar double-magnet type (Fig. 104).

(*a*) *Bipolar Types.*—The simplest form of field-magnet frame is that resembling the shape of a horseshoe. Such a horseshoe-shaped frame may be composed of two magnet cores joined by a yoke, or may be formed of but one electromagnet provided with suitably shaped pole-pieces. The former is called the "single-horseshoe type," the latter the "single-magnet type."

A single-horseshoe frame may be placed in four different positions with reference to the armature, the two cores either being above or below the armature, or situated symmetrically, one on each side, in a horizontal or in a vertical position.

The upright single-horseshoe type, Fig. 67, is the realisation of the first-named arrangement, having the cores above the armature, and is therefore often called the "overtype." This form is now used in the Edison dynamo, built by the General Electric Company, Schenectady, N.Y., in the motors of the C. & C. Electric Company, New York, and is further employed by the E. G. Bernard Company, Troy, N.Y.; by the Detroit Electrical Works, Detroit, Mich. ("King" dynamo); the Commercial Electric Company (A. D. Adams), Indianapolis, Ind.; the Novelty Electric Company, Philadelphia, Pa.; the Electron Manufacturing Company (Perret"), Springfield, Mass.; by Siemens Bros., London, England; Mather and Platt (Hopkinson), Manchester, England; the India Rubber, Gutta Percha, and Telegraph Works Company, Silvertown, England; and by Clarke, Muirhead, and Co., London.

The inverted horseshoe type, Fig. 68, having the cores below the armature, is also called the "under-type." Of this form are the General Electric Company's "Thomson-Houston" motors, the standard motors of the Crocker-Wheeler Electric Company, Ampère, N. J.; further, machines of the Keystone Electric Company, Erie, Pa.;



the Belknap Motor Company, Portland, Me.; the Holtzer-Cabot Electric Company, Boston, Mass.; the Card Electric Motor and Dynamo Company, Cincinnati, O.; the La Roche Electrical Works, Philadelphia, Pa.; the Excelsior Electric Company, New York; the Zucker and Levett Chemical Company, New York (American "Giant" dynamo); the Knapp Electric and Novelty Company, New York; the Aurora Electric Company, Philadelphia, Pa.; the Detroit Motor Company, Detroit, Mich.; the National Electric Manufacturing Company, Eau Claire, Wis.; Paterson and Cooper (Esson), London; Johnson and Phillips (Kapp), London; Siemens and Halske, Berlin, Germany; and Ganz and Co., Budapest, Austria.

Machines of the horizontal single-horseshoe type, Fig. 69, in which the centre lines of the two magnet cores and the axis of the armature lie in the same horizontal plane, are built by the Jenney Electric Company, New Bedford, Mass. ("Star" dynamo), by the Great Western Manufacturing Company (Bain), Chicago, Ill., and by O. L. Kummer and Co., Dresden, Germany.

The vertical single-horseshoe type, Fig. 70, finally, having the axes of magnet cores and armature in one vertical plane, is employed by the Excelsior Electric Company (Hochhausen), New York, and by the Donaldson-Macrae Electric Company, Baltimore, Md.

* From the *Electrical World* (New York).

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Single-core horseshoe frames may be designed by placing the magnet either in a horizontal or in a vertical position, or by joining two pole-pieces of suitable shape by a magnet of circular form. The types thus obtained are the horizontal single-magnet type, the vertical single-magnet type, and the single-magnet ring type.

In the horizontal single-magnet type, Figs. 71 and 72 respectively, the armature may either be situated above or below the core. Machines of the former type, Fig. 71, are built by the Jenney Electric Motor Company, Indianapolis, Ind.; the Porter Standard Motor Company, New York; the Fort Wayne Electric Company, Fort Wayne, Ind.; the United States Electrical Company, New York; the Holtzer-Cabot Electric Company, Boston; the Card Electric Motor and Dynamo Company, Cincinnatti, O.; the Simpson Electrical Manufacturing Company; the Chicago Electric Motor Company, Chicago; the Bernstein Electric Company, Boston; and by the Premier Electric Company, Brooklyn. The latter type, Fig. 72, is employed by the Electron Manufacturing Company, Springfield, Mass.; and by the Riker Electric Motor Company, Brooklyn.

The vertical single-magnet type, Fig. 73, is used by the "D. & D." Electrical Manufacturing Company, Minneapolis, Minn.; the Packard Electric Company, Warren, O.; the Boston Fan Motor Company, Boston; the Elbridge Electrical Manufacturing Company, Elbridge, N.Y.; the Woodside Electrical Works (Rankin-Kennedy), Glasgow, Scotland; by Greenwood and Batley, Leeds, England; and by Goolden and Trotter (Atkinson), England.

Fig. 74 shows the single-magnet ring type, which is employed by the Mather Electric Company, Manchester, Conn. Two magnets, instead of forming the limbs of a horseshoe, can also be set in line with each other, one on each side of the armature, or may be arranged so as to be symmetrical to the armature, but with like poles pointing to the same direction, instead of forming a single magnetic circuit with salient poles; the form will then constitute a double circuit with consequent poles in the yokes joining the respective ends of the magnet cores. In both of these cases the cores may be put in a horizontal or vertical position, and in consequence we obtain two horizontal double-magnet types, Figs. 75 and 77, and two vertical double-magnet types, Figs. 76 and 79.

The salient pole horizontal double-magnet type, Fig. 75, is employed by Naglo Bros., Berlin, and by Fein and Co., Stuttgart, Germany; and the salient pole vertical double-magnet type, Fig. 76, by the Edison Manufacturing Company, New York.

The consequent pole horizontal double-magnet type, Fig. 77, is used in the Feldkamp motor, built by the Electrical Press Company, Newark, N.J., and in the Fan motor of the De Mott Motor and Battery Company; and the consequent pole vertical double-magnet type, Fig. 79, by the Columbia Electric Company, Worcester, Mass.; the Keystone Electric Company, Erie, Pa.; the Akron Electrical Manufacturing Company, Akron, O.; the Mather Electric Company, Manchester, Conn.; the Duplex Electric Company, Corry, Pa.; the General Electric Traction Company (Snell), England; Mather and Platt (Hopkinson), Manchester, England; Immisch and Co., England; Oerlikon Works (Brown), Zurich, Switzerland; and Helios Company, Cologne.

If in the latter form magnets are made of circular shape the double-magnet ring type, Fig. 80, is obtained, which is built by the "C. & C." Electric Company, New York, and which has been used in the Griscom motor of the Electro-dynamic Company, Philadelphia.

The inclined double-magnet type, illustrated in Fig. 78, forms the connecting link between the double-magnet and the single-horseshoe types; it is employed by the Baxter Electrical Manufacturing Company, Baltimore, Md.; by Fein and Co., Stuttgart; and by Schorer, in Darmstadt.

(To be continued.)

Long Telegraph Line.—The longest telegraph line in the world is said to extend from Old Broad-street, London, to Calcutta, a distance of over 7,000 miles.

THE PRACTICAL APPLICATION OF ALTERNATING-CURRENT MOTORS.*

BY WALTER J. FRYER, A I.E.E.

It will perhaps be as well for us to first consider alternating currents from their theoretical aspect, and to afterwards follow on with illustrations of how alternating-current motors have been successfully applied in practice.

In England, all the companies supplying alternating currents use what is called the single-phase system of distribution, and owing to the demand for motors being very small they have not seen their way clear to lay down a separate system of mains. All motors have, therefore, to be connected up to the lighting circuits. Extreme care is necessary in designing installations where such motors are to be used owing to their taking a very large starting current, which would cause the pressure at the lamp terminals to vary greatly. One of the chief difficulties of running single-phase motors off lighting circuits is, that until quite recently they had only been designed to work where the frequency did not exceed 30 cycles per second. With lighting, it is both necessary and economical to have the frequency as high as 80, 100, or 130 cycles per second, as the eye can easily detect the variations in an incandescent lamp that is being supplied with the alternating current at a frequency of 30 to 40 cycles per second. Hence it was out of the question to think of supplying motors and lamps with electrical energy from the same circuit. These difficulties have been overcome, and they are now made to work with frequencies as high as 100 cycles per second. The frequency of a generator depends upon the number of revolutions per second of the armature, and upon the number of pairs of poles upon the field.

Another objection which is sometimes raised against single-phase alternate motors is that they have dead points at every reversal of the current. This is not a serious one, as they are so small and so numerous that they practically become of no account. There are sometimes as many as 200 of them in a second; not only so, but these dead points occur only when the rotor—that is to say, the revolving part of the machine—is not running in synchronism with the generator. Directly synchronism is obtained these dead points are eliminated. The motor must therefore be brought up to the same speed as the generator before closing the switches. Another way of attaining this end is by causing the resultant magnetic force to pass successively through a series of poles on the field in a rotary manner, giving a two-phase or multiphase machine. It can easily be seen that the lower the ⌣⌢ the greater will be the difficulty from dead points.

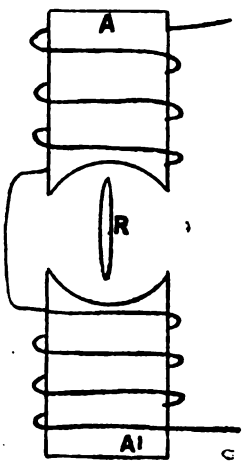

FIG. 1.

Referring to Fig. 1, A and A^1 are electromagnets. If we pass an alternating current round them and place a coil, R, of wire in the vertical position, it will turn and come to rest in that position in which it will cut the least number of magnetic lines—that is, in the horizontal position. This will then be a dead point. Now, in order to make the coil, R, go on rotating we must produce a second current at right angles to the first, thus creating a rotary field, but not a true rotary field. This can be done by placing two more electromagnets, B B^1, at right angles to A A^1 (Fig. 2), and so arranging matters that a current is first passed round the coils A A^1, producing magnetic lines in a downward direction and creating a N pole on the top and a S pole on the bottom. This causes the coil R to turn horizontally. Now cut off that current, which we will call No. 1, and pass a second current through the coils round the magnets, B B^1, making B a N and B^1 a S pole. This will cause the coil R to turn through a right angle into the vertical position. Switch off current No. 2, and pass current No. 1 through

* Abstract of paper read before the Institution of Junior Engineers on February 15, 1895.

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the coil A and then through A^1. The resultant magnetic force now passes upwards from A to A^1, producing a N pole at the bottom and a S pole at the top, and the coil R then moves into the horizontal position. We now repeat the operation with current No. 2, so that B^1 becomes a N and B a S pole; the coil gain takes up the vertical position and thus completes one

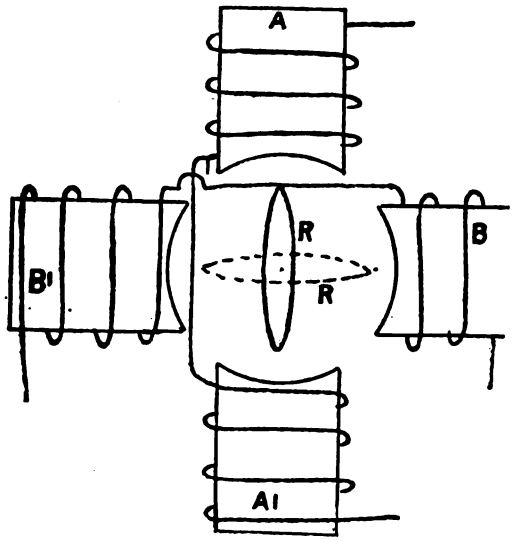

FIG. 2.

revolution, so also has the resultant magnetic force through the four coils. It must be remembered that the current does not rotate, but only the resultant magnetic force. This is exactly what happens with a two-phase rotary field motor, and on a steam-engine would be equivalent to putting the cranks at right angles to each other.

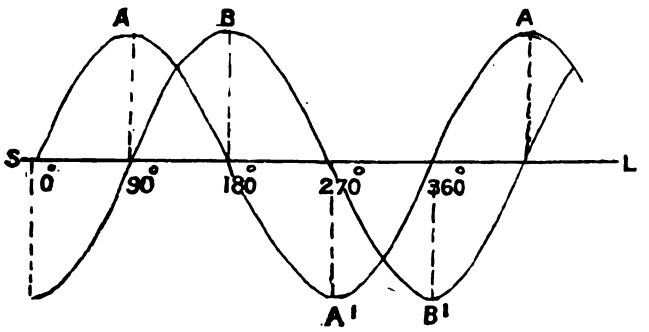

FIG. 3.

Such rotary fields are produced in the generator in the following manner: Instead of passing currents through the four coils, A A^1, B B^1, A^1 A, B^1 B (Fig. 2), a magnet is revolved in front of them. In this case the armature will be stationary, and it is the field that we are revolving, and producing two alternating currents which will differ in phase by a quarter of a period. This can best be illustrated by means of curves, Fig. 3. The straight line, S L, represents the circle through which the magnet passes in front of the coils. The resultant E.M.F. induced in the coil A gradually rises until it has reached the maximum positive value just as the magnet is passing under the centre of the coil, the E.M.F. then begins to die away to zero. At this point the magnet has travelled through an angle of 180deg., and the E.M.F. afterwards begins to assume a negative value. At the point where it crosses the line, S L, there would be a dead point in the motor, were it not that the E.M.F. in the coil B has now reached its highest possible value.

Fig. 1 represents a two-pole single-phase motor. Fig. 2 is a four-pole two-phase motor, the currents differing by 90deg. To build a three-phase generator or motor we must have six coils and six wires, if they are constructed as Fig. 2, giving phase difference of 60deg., or we can construct them with a phase difference of 120deg. by winding the field of the generator continuously round a ring of iron, as in Fig. 4. This is equivalent to joining the three ends of the six coils so as to form a continuous winding, and produces a true rotary field—the armature being a mass of iron plates with copper bars laid in close to the periphery to increase the conductivity, or else composed of sets of endless coils joined so as to form

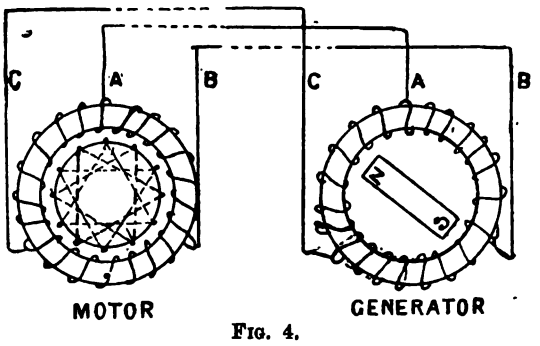

FIG. 4.

a squirrel-cage winding. In order that you may see exactly what takes place in a machine of this type, I have made a model, which was invented by your past-president, Prof. Thompson. Imagine that the two circles are the N and S poles of the field magnet, and that the lines A^1, B^1, and C^1, 120deg. apart, are equivalent to the three lines A, B, C. Now, when the two circles are revolved, the highest E.M.F. is being induced in A and then in coil B and C successively. The field of the single-phase Brown motor, shown in Fig. 5, is wound with thick-wire coils forming three N and three S poles, and it also

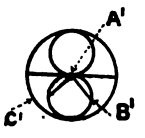

FIG. 4A.

has a set of thin-wire coils forming a second set of poles. The armature is wound in a similar manner, forming three sets of poles of six coils each. In order to make it self-starting, we must have two currents at right angles to each other. This is done by placing a liquid condenser, consisting of plates of iron immersed in a solution of common soda, in series with the fine-wire coils, and thus producing two currents in the field differing in phase by nearly 90deg. After the motor has run up to full speed the condenser and fine-wire coils are cut out of circuit, and there is then a simple oscillating field.

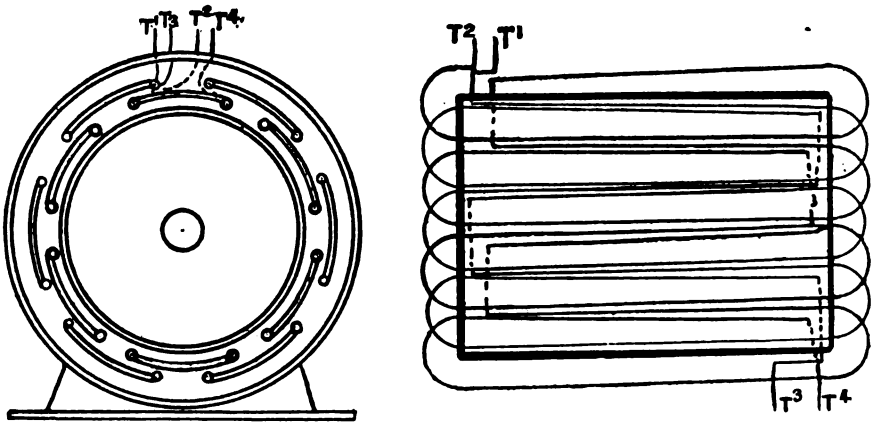

FIG. 5.—End Elevation—Sketch of Winding.

We have already said that the frequency of a generator depends upon the number of pairs of poles upon the field and upon the rate of speed of the armature. Therefore, the speed of a motor will depend upon the frequency of supply and upon the number of poles upon the field. The above motor is designed for a frequency of 100 cycles per second. Divide this by 3 and multiply by 60 and we get the speed = 2,000 revolutions per minute. In practice there is from 3 to 5 per cent. slip to

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be allowed for. By putting double the number of poles upon the field we should halve the speed. We cannot, however, go on increasing the number of poles indefinitely for both mechanical and electrical reasons.

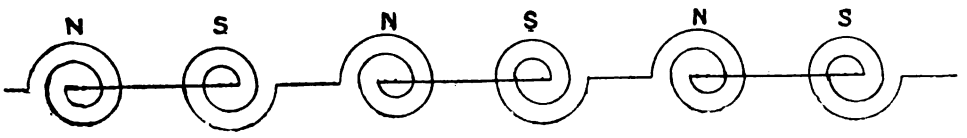

FIG. 6.

Each alternate coil upon the field is wound first right-handedly and then left-handedly, as Fig. 6, or if they are all wound right or left handedly then they must be connected as Fig. 7. The six coils are purposely shown in a straight line, so that the winding and connections can the more easily

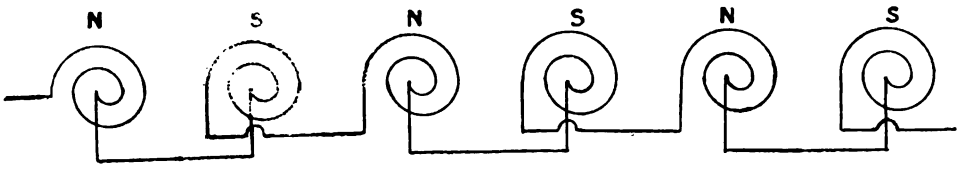

FIG. 7.

be traced. The reason for winding the coils in the foregoing manner is because the polarity of an electromagnet depends upon the way in which the current flows round it. Suppose we have a straight bar, A, of iron and wind it from left to right in a clockwise direction, looking at the left-hand end, and pass a current in the direction of the arrows, then the right-hand end will be the N pole, and the magnetic lines will flow outwards from the N pole. This necessitates connecting the coils so as to cause the currents to circulate as in Fig. 9, otherwise we shall have either all N or all S poles on the inner side of the field, and the resultant induced currents in the armature would flow in opposite directions in each winding, and would thus counteract one another. Fig. 5 represents the winding of the field of this machine. The armature is laminated, consisting of plates of iron having holes stamped out all round the periphery, through which coils of wire are threaded so as to form three sets of coils. One of the ends of each set of coils is taken to a common juncture, and the other three ends are connected to three insulated rings on the end of the shaft having copper brushes bearing upon them. A set of resistances is connected to each brush, and thus in series with each set of coils. The object of these resistances is to prevent the sudden rush of current which would otherwise take place when the motor is first started.

Having briefly touched upon the fundamental principles of these machines, I now propose to give you descriptions of installations where these motors have been successfully applied in practice, and to compare them with other forms of motive power. The first installation is one designed by the writer and applied to the blowing of organ bellows. In this particular instance there were really two organs (an additional organ having been built some 15 years after the first one), each having its own separate bellows and set of mechanism. This very much complicated matters, as it was necessary that the motive power should be divided, so as to be capable of being utilised for either or both organs. To effectually supply air to organs by means of mechanical power it is necessary that the whole of the plant should be completely under the control of the organist, and that everything should as far as possible be arranged to act automatically, as the organist has quite enough to occupy his attention in regulating 60, 70, or even 100 stops.

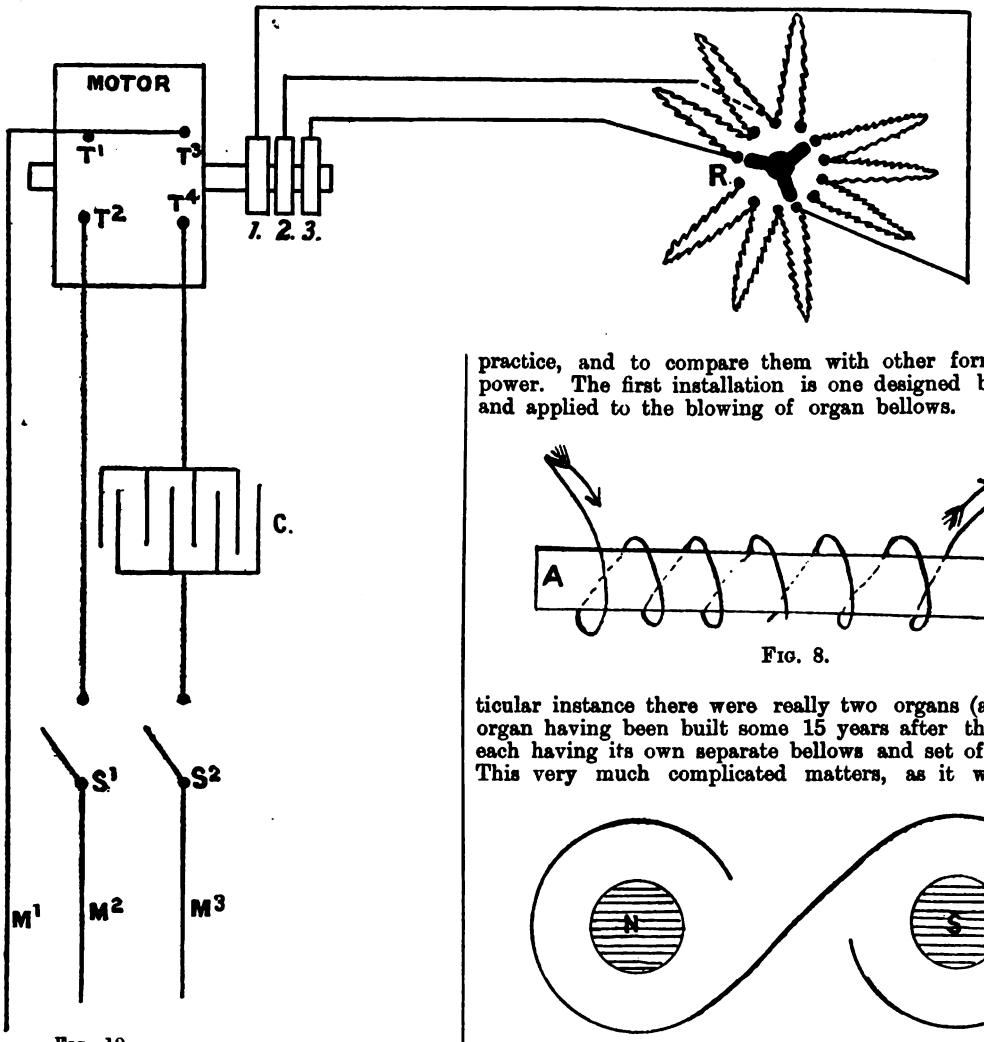

FIG. 10.

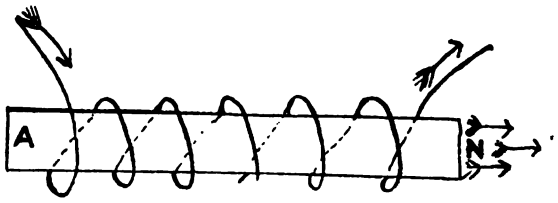

FIG. 8.

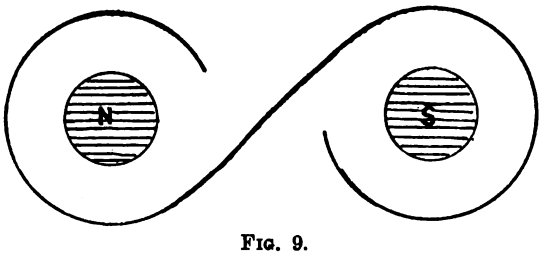

FIG. 9.

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Up to the present hydraulic power has been chiefly used, as it was most easily regulated, worked smoothly and without noise, and, above all, is self-starting. It has, however, one great drawback. In winter it is not always possible to thoroughly protect the motor from frost, being more often than not placed in a cold, damp cellar.

Gas-engines are occasionally used, driving by means of belts on to fast and loose pulleys connected to the crankshafts. As the windchests are filled they automatically shift the belt from one pulley to another by means of small levers, which only come into action when the windchests are nearly full or nearly empty. The main objections to gas-engines are: (1) they are not self-starting on load; (2) will not work in a confined space; (3) are noisy; (4) require constant cleaning and attention.

With electromotors the case is very different, as they have the advantages all on their side, and, briefly tabulated, are as follows: (1) they are exceptionally economical, as the energy consumed is directly proportional to the work done; (2) they can be placed in any position; (3) they are free from noise; (4) they are self-starting; (5) they are perfectly under the control of the organist; (6) they cannot be frozen out; (7) they require the minimum of floor space; (8) the speed can be varied at will; (9) they can be arranged to act automatically.

Direct-current electromotors undoubtedly faithfully fulfil all

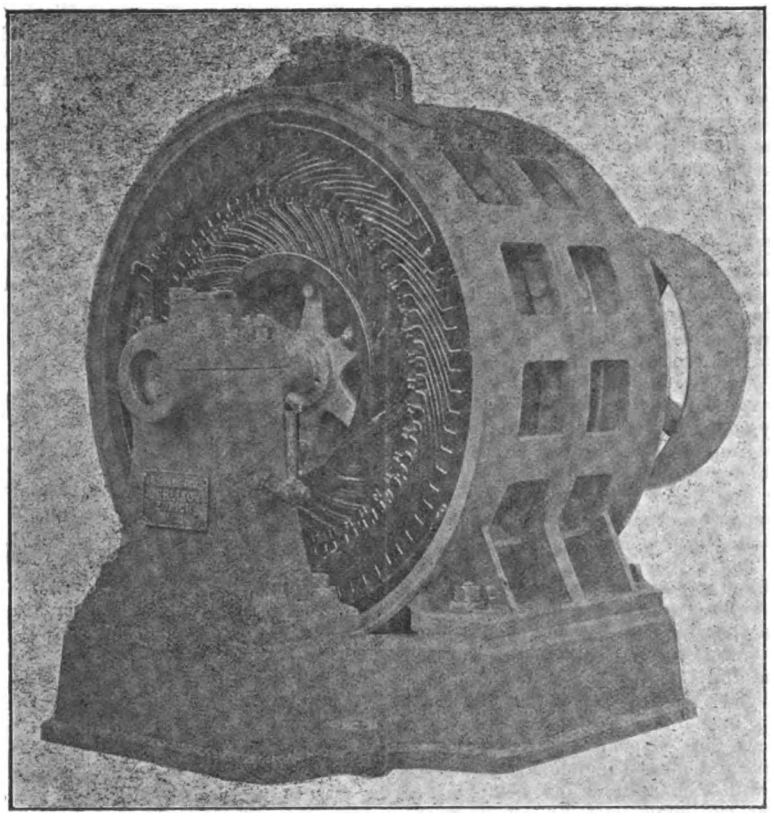

FIG. 11.

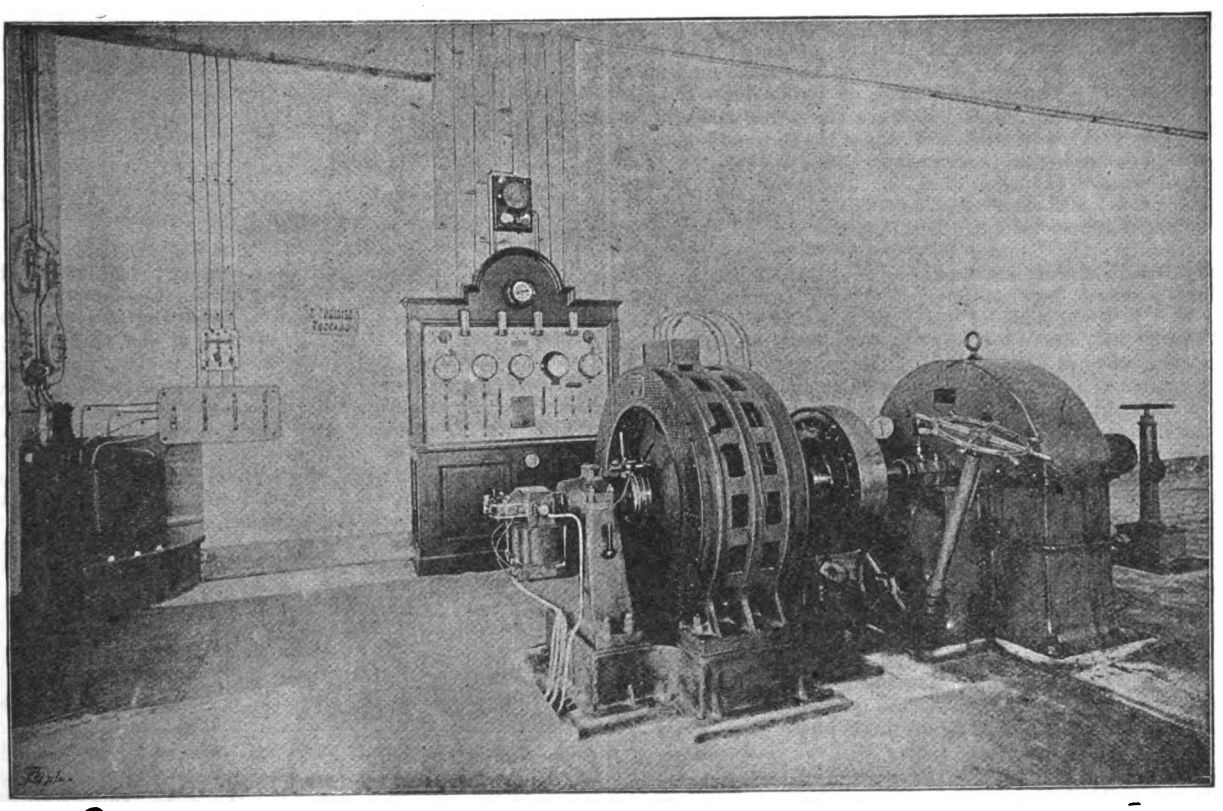

FIG. 12.

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these conditions, but to-night we are considering the application of alternating-current motors, and in this particular case a single-phase one had to be used. A description of the winding of this motor, with the various arrangements for making it self-starting and for preventing the sudden rush of current, has already been partly given.

The motor is a 3-b.h.p. one, capable of working up to 4½ h.p. for short periods; the speed is 2,000 revolutions per minute; length of shaft over all, 1ft. 8¼in. The lubrication is carried out by means of loose brass rings dipping into oil. Frequency is 100 cycles per second; voltage is 100; starting current about 68 amperes; current at full load, 41 amperes. It is connected on to a worm (which is cut out of the solid), by means of a cone coupling. The wheel consists of 40 teeth, thus giving a speed of $\frac{2,000}{40} = 50$ revolutions per minute to the pulleys. The wheel is keyed to a 1¾in. shaft supported by two adjustable plummer blocks on sole-plates, the 10in. by 4in. pulleys being keyed on to the outside of the plummer blocks, and the whole of the gearing is enclosed in an oil bath. The power is then transmitted by means of two double leather orange tan belts, travelling at 135ft. per minute.

At first sight it may appear strange that the levers were not connected directly on to the wheel shaft by means of cranks, and that a great saving in power and cost would thus have been effected. The chief reason against this was that we have to supply power from one motor to two distinct sets of bellows feeding the two separate organs. It was therefore absolutely essential that each set of bellows should automatically take power from the motor as required, and that when either set of bellows were filled any excess of power should be transferred to that set of bellows which was being worked at the quickest rate. Imagine that by some means the power of the motor has been divided into three parts. One third works the first bellows, the second third works the second bellows, and the last third dodges backwards and forwards. Had the belts, clutches, and shafting been dispensed with, two motors would have been required, two sets of gearing, a double set of switching and starting gear, and altogether the arrangements would have been more complicated and not so elastic or so automatic as the above. The supply of energy is taken off the mains of the Metropolitan Electric Company, and separate transformers have been put in for the lighting and power. This was done so that the switching on and off of the motor would not affect the pressure at the lamp terminal.

The connections to the motor are shown in Fig. 10, where the mains, M^1, M^2, bring in the supply. Main M^1 is connected on to terminals, T^1, of the thick-wire coils and, T^2, of the fine-wire coils. Main M^2 is connected on to the thick-wire terminal, T^3, having a switch, S^1, in circuit with it at the point P, a branch is teed on to main M^2 and is connected to a condenser, C, through switch S^2, and then to the remaining fine-wire terminal, T^4. The two windings of the field are thus in parallel with each other; 1, 2, and 3 are the three rings upon the armature shaft connected to the ends of the three sets of coils, and having brushes bearing against them connecting the different resistances, R, into the three circuits. The resistance, R, has three steps to it, each step being cut out of circuit by a three-way laminated copper bridge. The motor is started by closing the switches S^1 and S^2, and putting the whole of resistance, R, into circuit with the armature; thus the motor for starting is a two-phase machine, because the current going through the condenser and fine-wire coils of the field is in advance nearly a quarter of a period over the current through the thick-wire coils. When the motor has attained full speed S^2 is opened, cutting out the condenser; and the resistance, R, is then gradually cut out of circuit until the coils on the armature are short-circuited. As these five operations would cause the o ganist a good deal of bother, they have been arranged to actr automatically, so that he only has to pull a small lever round through a third of a circle, and by so doing closes and opens the various switches. The time occupied is not more than 20 seconds.

An electrical contact arrangement has also been devised, and fitted to the shaft of the motor, so that when the motor has attained full speed a ball flies out and makes contact with a brass plate. This causes an indicator on the keyboard of the organ to drop, warning the organist that it is time to pull the lever of the switch right over, cutting out the condenser and resistance, and as the latter is cut out the circuit to the indicator is broken, so that the battery does not run down. This is, I believe, the first single-phase, self-starting motor put down in England of over 1 h.p. Switzerland is, however, the country where we find alternating motors working to perfection. At the locomotive and boiler works of Messrs. Escher, Wyss, and Co., of Winterthur, they have something like 900 h.p. on the three-phase system, the generators being worked by turbines at a distance of 16 kilometres = 9·936 miles. The large tools are worked by separate motors of 60 h.p. and 70 h.p. The smaller motors, of 3 h.p. and 5 h.p., are coupled up to shafting by means of belts, and work four or six small tools, such as lathes, drilling machines, etc. In the old works driven by steam and shafting, they required 2,000 h.p. to do exactly the same amount of work as the present electrical plant of 900 h.p. In calculating the enormous saving thus effected the amount of floor space saved must also be taken into consideration.

The Oerlikon Electrical Works have also a very perfect installation. I am able to show you a few photographs taken direct from the installation by Mr. Bathurst. The generator has a frequency of 48 cycles, pressure 50 volts, and generates three-phase currents. These low-pressure currents are taken into transformers with oil insulation; the pressure is transformed by them up to 13,000 volts. It has then to traverse a distance of 15 miles to the works, where it is transformed down again to 190 volts. Fig. 11 shows a 40-h.p. three-phase motor, with eight poles, running at 750 revolutions and 50 cycles.

In all these installations the great simplicity of working cannot but be noticed, as the motors have neither brushes nor commutators, which, as most of you know, are the parts which give the most trouble and require most attention in direct-current motors. They can also be safely overloaded as much as 50 per cent. without any fear of breakdown. It thus becomes next door to impossible to burn them out.

I have had a sheet of designs printed for your inspection to-night. Fig. 12 is the interior of the generator-room, showing the turbine, generator, switchboard, transformer, and general arrangements. Fig. 13 is the interior of the generator, showing the manner in which the coils are connected and the ease with which they can be got at for repairs. The field is separately excited by an exciter placed upon the end of the shaft, has 12 poles interlocking with each other, the winding being taken between the poles and held in position by them.

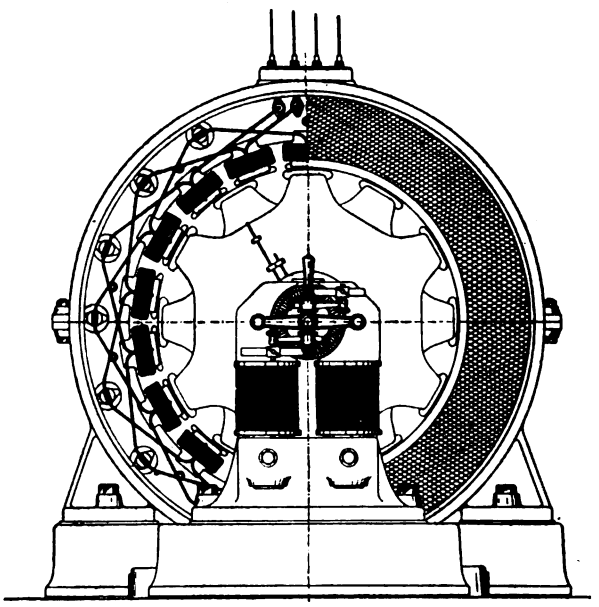

FIG. 13.

I have also for your inspection various machines of 3 h.p., ¾ h.p., and 1-10 h.p. They are of the Oerlikon make, and have special starting arrangements, consisting of a small transformer placed in circuit, with one set of the windings taking a small current at 100 volts from the mains, and giving a relatively large current at small voltage to the motor. A resistance is placed in series with the second winding. The rotor, or armature, consists of iron plates having copper bars close to the periphery, as previously explained. In conclusion, I have to thank Mr. Hirst, the General Electric and Oerlikon Companies, and Messrs. Joel and Bowen for their kind assistance and for the loan of these machines.

CANADIAN MICA.

The samples of Canadian mica on exhibition in the Canadian Section of the Imperial Institute, Imperial Institute-road, S.W., to which we referred in our last issue, comprise three varieties—viz., brolite (or black mica), phlogopite (or amber mica), and muscovite (a potash mica, usually white). Prior to 1890, Canadian mica was chiefly worked to supply the stovemaking trade, but owing to the demand which has recently arisen for the mineral for electrical purposes, the mica industry of Canada has developed largely during the past five years. Most of the Canadian mica is mar-

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keted in the United States, where the amber variety is used by manufacturers of electrical machinery. The bulk of that employed by the Edison General Electrical Company is Canadian mica of the amber-coloured variety. The value of the total output of Canadian mica in 1889 was 28,718del., as compared with 75,719dol. in 1893. The value of the total exports was 30,597dol. and 70,081dol. respectively. The samples recently sent to the Imperial Institute are all from the province of Quebec, and were obtained chiefly from deposits occurring in the Laurentian rocks of the valley of the Gatineaw River. They are supplied by Messrs. Powell and Clemow, W. A. Allan, Cascades Mica Company, and Vavasour Mining Association of Ottawa, and Mr. G. B. Hall, of Quebec.

NEXT WEEK'S NEWS TO-DAY.

Mr. Justice Mathew will to-day (Friday) take his seat as a commercial judge, and will continue to sit for the despatch of commercial business.

Engine, boiler, and dynamo makers will be interested in learning that circulars have been issued to 200 iron firms containing the draft scheme of a projected Midland Iron Trade Association.

The jury who yesterday returned a verdict of accidental death in the case of the City lift fatality evidently had in mind the use of electric power when they added a rider to the effect that all lifts used for passengers should have some automatic arrangement by which similar accidents may be prevented in the future.

Lord Rayleigh will commence a series of six experimental lectures at the Royal Institution on Saturday on "Waves and Vibrations." A duplicate apparatus for the production of argon having been fitted up in the physical laboratories in Albemarle-street, Lord Rayleigh will be able to show some of this much discussed "element" during his lectures.

The Home Secretary in the House of Commons yesterday evening stated that he hoped to introduce a Bill dealing with shot-firing in coal mines, and that special attention would be given to the recommendations of the Royal Commission on Explosions from Coal Dust in Mines. It will be remembered that among the recommendations of the latter is the advice that shot-firing by electricity should be more generally adopted.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 28.

MR. R. E. B. CROMPTON (President) in the chair.

At last night's meeting of the Institution the following candidates were balloted for:

Foreign Member.—Henry Fleetwood Albright, 5304, Lancaster-avenue, Philadelphia, Penn., U.S.A.

Associates.—Edwin H. Barton, D.Sc. (London), University College, Nottingham; Captain F. Baylay, R.E, School of Military Engineering, Chatham; Nelson Dadge, 18, Cecil-court, Charing Cross-road, W.C.; Lieut. A. H. Dumaresq, R.E., School of Military Engineering, Chatham; Frank Burridge Foy, St. Vincent, Cape de Verde Islands; Lieut. M. E. R. Maunsell, R.A., Royal Military Academy, Woolwich; Herbert Nash, 19, Palace-gardens-mansions, Notting Hill Gate, W.; William Llewelyn Phillips, Cedar House, Romilly-crescent, Canton, Cardiff; Eustace Thomas, B.Sc., the Technical College, Leonard-street, Finsbury.

Students.—Frederick John Caley, 8, Barclay Park-terrace, Knott's Green, Leyton; Norman Endacott, the Technical College, Leonard-street, Finsbury; Arthur Thomas Gordon-Smith, Faraday House, Charing Cross-road, W.C.; Reginald Charles Harpur, Faraday House, Charing Cross-road, W.C.; Hugh Godfrey Nicholson, 346, The Cliff, Higher Broughton, Manchester; Edward Fairlie Watson, 4, Priory-road, Kilburn, N.W.; Norman James Wilson, 28, Trafalgar-square, South Kensington, S.W.

Before the discussion was resumed on Mr. W. B. Sayers's paper on "Reversible Regenerative Armatures and Short Air Space Dynamos," the author further explained certain formulæ which at the meeting on the 14th ult. he had placed on the blackboard, but which he thought had not been well understood, as they had not appeared in the printed paper.

Prof. S. P. Thompson congratulated Mr. Sayers on the progress he had made. There was a main line of thought in the work. The author wanted to get over the difficulty of sparking at the brushes, and then to employ copper and iron to greater advantage. The original way was to give the brushes a forward lead so that the reversals might take place. Various other ways had been tried. One had been to employ an air flash to blow out the spark. Mr. Mordey had created a separate magnetic field for the same purpose. Both Messrs. Esson and Swinburne had advocated auxiliary poles. Mr. Sayers had done it by notching. Then there came the method known as Prof. Ryan's of winding a series coil over the armature, or cross-compounding. The objection which had been raised to Mr. Sayers's method in his previous paper, that he could only revolve in one direction, had now been removed. The speaker then proceeded to explain what he took the nature of the author's dynamo to be. The armatures now proposed were different from those of two years ago, being of the drum construction. He wanted to know if anyone had any experience of running any of the Hutin-Leblanc machines (which we described and illustrated some time ago). He had had no experience of the latter, but he described it with the assistance of blackboard diagrams. Mr. Sayers had mixed up slotted armatures with tunnel armatures, whereas they were quite distinct. The difficulty in the slotted system was that the insulation was difficult, and he would like to know how Mr. Sayers had carried it out. In the United States there was not 5 per cent. of the dynamos made which had smooth armatures. He did not know under what circumstances anyone would want a dynamo to run in both directions save in the case of railway train lighting. The machine weighed 67lb. for each horse-power when run as a motor, but he thought that a machine could be made for less. He thought it inadvisable to put all the copper in the armature.

Dr. du Riche Preller referred specially to the matter of weight, but a reduction in weight did not necessarily mean a reduction in price, and, for instance, where a motor was used for traction purposes it was inadvisable to make it too light. The author's 80-kilowatt machine weighed 3½ tons, or 100lb. per kilowatt. Mr. C. E. L. Brown's 60-kilowatt machines weighed 2 7 tons, or 90lb. per kilowatt- The Brown 90-kilowatt machine was 90lb. The ordinary Brown 80-kilowatt machine was 117lb., and this could have been reduced to 100lb., but the designer had refrained from doing so for practical work. The Thury dynamos of the Geneva Electrical Company were about 110lbs. per kilowatt. Mr. Sayers claimed an efficiency of 96 per cent. That might be a test efficiency, but he doubted if it would be obtained in practice.

Mr. Evershed followed with a mixture of jokes and practical information. The only real difference in the ways of sparkless commutation was in obtaining the induction. He thought the labour of winding the armatures was increased where the weight was diminished. Mr. Sayers had devised an admirable, though rather complicated way of reversing. With reference to a drawing on the wall of a dynamo by Mr. Ravenshaw, he had held in theory that there must be sparking somewhere but he had seen it working and found absolutely none. Mr. Sayers was the only man who had had the courage to deal with the question of improving continuous current dynamos. It might not be the best method, but it would do.

Mr. R. E. Crompton, in closing the discussion, remarked that there was rather a tendency to undervalue the author's invention, on the ground that the plain slotted armature was sufficient. Dr. Preller had compared the Sayers machine with that made by Mr. Brown, but the conditions on the Continent and in England were entirely distinct. If Mr. Brown was called upon to produce a machine like those made in England, with the high efficiencies of 96, and even 97, per cent., he would make them heavier.

Mr. W. B. Sayers, in replying to the discussion, contended that if the proportions he had given were carried out, there would be no heating whatever of the pole-pieces or any measurable loss of power as contended by Mr. Anderson and others. With regard to Dr. Preller's observation concerning slotted and tunnel, the reason he had used the terms was because he had merged one into the other, as was explained on the blackboard, and he had unconsciously slipped into the way of calling them by that name. Dealing with parallel running, the speaker said that the coupling of direct current machines in parallel did not depend upon whether they had compound or forward coils, but upon the characteristic. If the machine had a falling characteristic the arrangement was quite stable. Discussing the question of weights as set forth by Mr. Anderson, Mr. Parshall, and Dr. Preller, he stated that on comparing his type of machine with those described by those gentlemen, and with those of other makers, he found that the ratio was as 5 to 8. The Brown machine was of the four-pole type. If he, the author, made four-pole machines, their weight would be approximately half that mentioned in the paper. Treating of Mr. Mordey's remarks in regard to certain words, the author regretted that he had used various terms to express commutator segments. The doubling of the commutator coil allowed of the use of the poles referred to on the wall diagrams; their use was to increase the effectiveness of the commutator coil to the extent of something like 75 per cent. Referring to the reversing pole-pieces, the author stated that they largely increased the output of the machine for a given weight. Some speakers were under the impression that the main object was to get a regenerative action from the armature with a view to keeping up the voltage, but the chief advantage was that enough current could not be put on the armature to destroy the reversing field. Having dealt with some other matters touched upon in the discussion, the author decided to give the remainder of his reply in writing for publication in the *Journal*.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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CENTRAL-STATION LIBRARIES.

If we might venture to make a suggestion which certainly to a limited extent concerns ourselves—and, so far, may be thought to be biassed—it would be that all companies and authorities owning a central station should provide the employés with a good technical library. The men themselves ought to regularly buy their technical periodicals as each individual chooses, but it is too much to expect some of the younger ones or apprentices to equip themselves with a first-class technical library. And yet no man, be he stoker, manager, or director, ought to be without the reach of such technical books. The same may be said of members of local authorities. They should be able to check statements made to them by reference to standard authors, and if our idea of a technical library at each central station was carried out there would be no difficulty in doing this. The knowledge required in order to carry out almost all central-station work is such as ought to be easily attained by any person of average intelligence. The men employed about the engines and dynamos ought to have some knowledge of mechanical engineering, and be able to carry out many of the little repairs that are often made an excuse for shirking work. Simple books on the steam-engine, the boiler, and the dynamo ought to be at hand and be studied. The men should know something about shafting, belting, lubricants, and lubrication; should have some little knowledge of the theory of steam, the calorific value of fuels, the various ideas about stoking, feed water, condensing, the impurities likely to be met with in the water used for the boilers, and the best way to counteract the effect of such impurities. In order to obtain this information, the men who have not had the advantage of any special training should be induced to attend the science classes held under the auspices of the Science Department or the City Guilds Institute. Men should be encouraged to look and work upwards, and the only way to do this is to obtain knowledge. The old axiom still holds good, "knowledge is power," and will be so long as this world endureth. Then, while we should strongly urge every man to obtain a small technical library of his own, we cannot but recognise that often his means are limited, and he cannot obtain what he would like. It is here the works' library should come in. Our views, of course, are just as applicable to any other industry as the one we are appealing to at the moment. Many factories, we are glad to know, have both library and reading-room. These ought to be extended to every works. The success of such libraries depends very much on the librarian. In some places the books are hardly ever consulted—the men are not readers, is the excuse. Well, few men are readers after they have left the hands of the schoolmaster. More is the pity. But they can be influenced for their own good. They can be led to see that the difference between themselves and the men in the rank next above is a pure question of knowledge. In large works where a number of apprentices are taken, principals ought to look after

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the manual experience and dexterity of those placed in their charge, and to see that they have opportunities of acquiring the requisite technical knowledge to move upwards in the profession they have chosen. This view of the case is fully recognised in several works. In electrical works we may mention one of the earliest in Messrs. Crompton and Co., who obtained the services of Prof. Fleming as lecturer some years ago, and who have more recently obtained the services of other lecturers, so as to give their pupils the benefit of theory as well as of practice. But even in these works we venture to think the necessity of a technical library has been overlooked. Most of the apprentices or pupils, or whatever name they go by, probably obtain the best books upon the subject directly before them, but where the individual effort is most likely to fail is in obtaining the books which only indirectly bear on the subject. The calorific value of various fuels will not appear as of any value to the pupil in an electrical works, but he may have charge by-and-by of a central station and have a large voice in the purchase of fuels, when he will find that even coal differs and requires a little attention for economic purchase. It was our intention at the outset of this article to suggest various means by which a technical—and within this term we include a reference—library might without difficulty be obtained. With one exception, however, we shall reserve our remarks on this head—the exception being in reference to fines. Almost all works have a custom of imposing fines for certain lapses of duty. These fines might be used beneficially by using them for the purchase of books for the library. But we are in hopes that those most interested in the matter will favour us with their views on the subject.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TESTING INSTRUMENTS.

SIR,—Referring to your notice of recent catalogue of electrical testing instruments, my attention has been called to a description therein of a galvanometer designed and patented by me in 1891 to 1892, and named by permission "The Ayrton-Mather Galvanometer." I note that the illustration and description in that catalogue correspond to my list No. 2 of 1892 (No. 76), and would point out that the detail and arrangement of the instrument in question are covered by my patent No. 4,276 of that year. I regret that the firm issuing this list should copy the original designs of other makers.—Yours, etc.,

ROBT. W. PAUL.

44, Hatton-garden, E.C., February 27, 1895.

FATAL ACCIDENT AT BRISTOL.

SIR,—A most deplorable accident occurred at one of the sub-stations of the Bristol Corporation electric light works on Monday afternoon, February 25, resulting in the death of a linesman.

The deceased, Robert Coleman, had been engaged by the Corporation as a linesman for 12 months, prior to which he had been employed by Messrs. Siemens Bros., National Telephone Company, etc., and was a thoroughly sound and good man in every respect.

Coleman had been entrusted with the keeping in order of the sub-stations for some months past, and at the time of the accident was wiping down the high-tension board with a cloth, and was wearing an indiarubber glove on his right hand for the purpose. Whilst so working he looked away to speak to another person present, and the back of his left hand accidentally came in contact with a fuse terminal, he thus making contact to earth with the 2,000-volt mains.

Every effort to restore him was without avail; a medical man was on the scene within two minutes.—Yours, etc.,

H. FARADAY PROCTOR.

Bristol Electric Light Station, February 27, 1895.

P.S.—At the inquest held at 4 p.m. to-day (Wednesday) a verdict of "accidental death" was returned.

REVIEWS.

What is Heat? A Peep into Nature's Most Hidden Secrets. By FREDERICK HOVENDEN, F.L.S., F.G.S., F.R.M.S. London: W. B. Whittingham and Co.

Oh, dear! We do like a good old heterodox person, but we do not like an heterodox person that is seemingly unconscious of twisting everything topsy-turvy to suit his own purposes. Mr. Hovenden is one of these. In this book he falls foul of the mathematician in the first place, and because he cannot understand the conventions of simple arithmetic, characterises all mathematical science as founded on fundamentally wrong principles. Even such a petty thing as $1 \times \frac{1}{2} = \frac{1}{2}$ beats him, and four pages later on he grandiloquently writes: "Now, reader, can your *mind* understand that addition is subtraction; in other words, that 6 objects multiplied $\frac{1}{2}$ times become 3 objects ($6 \times \frac{1}{2} = 3$)?" That is what we term wresting mathematical symbolism and methods to illustrate what they don't mean. Any schoolboy would laugh at the teaching and tell the teacher that $6 \times \frac{1}{2}$ was simply another way of putting the question, What is the half of six?; or, taking the half away from six, what remains? Or, again, if they must retain the addition form Mr. Hovenden so continually puts forward as multiplication, they would transpose his question and say, How many whole objects do six halves make?

Yes, Mr. Hovenden starts wrongly. We do understand much, if not all, that he says we do not, but, of course, we do not translate in the form he puts forward. Talking about zero again on page 15, he says: "These very facts show the artificial condition of things." Of course they do. Zero can be what you please to make it. Its position on the Centigrade or Fahrenheit scale has nothing to do with the fundamental principles of mathematics, or being different on each scale makes neither of them incorrect. To attempt, however, to refer to the mathematical fallacies underlying Mr. Hovenden's description would take as much space as his statements do, while to criticise and explain them would require a volume.

But though we deride Mr. Hovenden's statements in regard to mathematics generally, we have much in common with him when he goes on to discuss the fault of interpreting Nature by means of mathematics—symbols, formulæ, and suppositions or assumptions—the result being usually in the form of K (known facts), where K is a constant which has to be determined for each separate substance.

We know that Clerk Maxwell in his later days preferred Faraday's experimental, and what we may term physical, path of investigation rather than pure mathematical induction. Here we agree especially with the quotations from Dr. Lodge—which are numerous—though we doubt Prof. Lodge would agree with the author's remarks and deductions.

In Part II. the author deals with the kinetic theory, and here, among much that is right and very well stated, he gets into wrong grooves and thus draws wrong conclusions. After quoting from "Chambers's Cyclopædia" about the atomic theory, he says: "According to this view there is, therefore, *no permanent contact between the objects of which matter is composed—atoms and molecules*; there can be no adhesion or cohesion, because this implies permanent contact."

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It implies nothing of the kind, except as understood for the purposes of our author. We may just as well understand that cohesion allows a molecular movement as that it implies molecular contact. Again, there is not necessarily molecular impact during molecular motion. Says our author, page 56: "According to this view, the particles are never still—their motions are *eternal* in temperate or tropical climates." Is there anything strange in this view, though we are not concerned to bolster up the theory of continued molecular motion? All that we are concerned about is to maintain there is no difficulty in following the reasoning of physicists in this direction, and unless Mr. Hovenden has a better theory, the physical concepts about atoms and molecules form a good working theory. But we must hurry on, simply but firmly contending that all physicists worthy the name and approaching the highest ranks admit their theories to be tentative. They are better than what has gone before, and will serve as a stepping-stone to what is to come after—at least, such is our idea gained from hearing the men speak and talk many a time. We say such is our idea of the views of Kelvin, Rayleigh, Rücker, Dewar, Lodge, FitzGerald, Glazebrook, and many others.

Up to page 113 we have only got criticisms of others, and argument as if physicists assumed infallibility for their theories. At this point we have impressed on us that "matter is built up of atoms," and weight is due to gravity acting. We thought a few pages before that we were going to have an explanation of what gravity is—but not yet.

The theory of Mr. Hovenden with regard to heat is that it is merely a question of "ether" absorbed. Objects which have absorbed equivalent quantities of ether are at the same temperature. If one object, however, has absorbed more than the other, it is hotter; if less, it is cooler. Although we fancy to have read or heard of phlogiston or a phlogistic theory in times gone by, this seems to be a recrudescence of something similar, only here the "ether" does duty as the heat and probably life-giving substance. We would not have missed reading this book for a considerable prize, for there is much in it we look upon as good and true, although, as is seen, we cannot agree with the author in his denunciation of mathematicians and physicists. Many of his experiments are simple, beautiful, and instructive. There is one fault we must refer to—the constant iteration of the words "impossible," "absurd." Scientific men have concurred in theories he applies these words to, so that it is possible to obtain such "concepts." We must also suggest that in this book are many statements, which are not proofs, and the author is as dogmatic as any of those he criticises. We had marked many passages for quotation and comment, but must content ourselves with a small portion. On page 119 the author says: "'Heat' and 'electricity' are words or terms expressing the reactions caused by the absorption and flow of an *incompressible* fluid passing *into and through* the atom or molecule. This fluid we will call *ether*; it is, we shall presently demonstrate, easy to be seen. Most likely it is a compound fluid." On pages 134-143 he describes the apparatus and experiments by means of which he says you can see this "ether," but, as a matter of fact, the experiment proves nothing. The author says, there you see the ether—but it is statement, and nothing more. He assumes that a heated red-hot iron rod has taken up ether, and in the experiment says that is ether. Do we want any artificial apparatus to see this antigravitational action? It is analogous to the haze on a hot summer's day which the lazy hammock swinger sees gravitating upwards, yet there certainly are plenty of beautiful phenomena in these experiments. In reading many of these experiments, we continually ask what part does temperature play in them? Even hot air will antigravitate. But enough. This book contains much that is interesting, much that ought to lead to thought, much that is true, many very excellent and instructive experiments, but it at the same time makes assumptions quite as remarkable as any made by mathematicians; it makes statements and assumes they are proofs; it abuses physicists as promulgating innumerable concepts which are not to be understanded of the people, and are stated to be absurdities; the conclusions and explanations are often glaringly contorted, and yet with all this it is well worth reading, if only to see how easily it is to err. Such books do good if studied in the right way, but it must be with an open mind. We know not whence the next best theory is coming, and although Mr. Hovenden has, we think, failed to prove his point, he has most certainly shown how easily existing theories can be attacked, their frailties and weaknesses made plain. Mr. Hovenden is a scientific heretic, but we must not forget, as Mr. Andrew Lang points out in the *Nineteenth Century* for February, that "heretics have in a certain small proportion of cases been in the right."

The Electric Current: How Produced and How Used. By Prof. R. MULLINEUX WALMSLEY, D.Sc., F.R.S.E. With 379 illustrations. Cassell and Co. Price 10s. 6d.

Electricity in the Service of Man: A Popular and Practical Treatise on the Applications of Electricity in Modern Life. By R. WORMELL, D.Sc., M.A. From the German of Dr. A. R. von Urbanitzky. Revised and enlarged by R. Mullineux Walmsley, D.Sc., F.R.S.E. With more than 950 illustrations. Cassell and Co. Price 10s. 6d.

We have placed the larger and earlier issued treatise in the second position, inasmuch as we have referred to it on more than one occasion before This is the third edition, and has been made much better by the care and attention of the reviser. It partakes very much of the character of a cyclopædia—trying to describe everything—and as the description is good, and the illustrations numerous, the book should appeal to the popular taste, which likes to dip a little into many things and obtain a superficial knowledge of various subjects without much trouble, or desire to sift the matter to the bottom. The first-named book, however, is of a different character, though retaining somewhat of the popular style. It is well written, and should strongly appeal to students who desire to make themselves acquainted with electrical matters. It is a general rather than a special treatise, inasmuch as it treats more or less lengthily the whole of the prominent applications of electricity. The greatest attention and space, however, is paid to the application of light and power. The work commences with a short historical account of the subject, and then we have described the methods of producing electricity, with descriptions of primary and secondary batteries. We are glad to see the student's attention so carefully directed to "the thermal values of the chemical reactions that take place in the cell" (pp. 40, 44-49). Chapter IV. brings us to magnetism, the earlier paragraphs in the chapter being historical and descriptive of various simple reactions. It is not our intention to discuss at any length more than one or two points whereon we differ with the author, for we think that on the whole this is one of the best books that have ever been written for the general student. But upon one or two points we must have a say, in that we think the explanations wrong. On pp. 99-100 we get the following illustration and description:

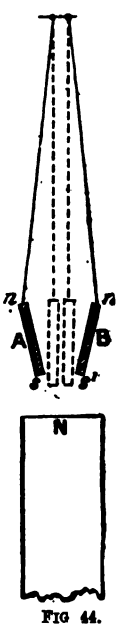

FIG 44.

"**Magnetic Induction.**—That a magnetic body placed near a magnet is for the time being polarised, and itself a magnet, can be shown by a number of striking experiments, from which we shall select one or two. One of the simplest is the following, due to Gilbert: A and B, Fig. 44, are two short pieces of soft iron suspended by long threads, as shown; before the magnet pole (N) of a permanent magnet is brought near to them, they hang side by side in the position shown by the dotted lines. But when either pole—for instance, the north-seeking pole (N) of a powerful permanent magnet is brought underneath and near to them—they assume the position shown by the full lines. Gilbert explains this action by saying that the two ends of the little pieces of iron nearest to N become poles similar to one another, but dissimilar to N, whereas the farther ends become similar poles to N. We have indicated this state of affairs in the figure by the small letters, s, n, s^1, n^1. Now, as the magnetic law is, that like poles repel, we have s and s^1 mutually repelling one another. Hence the little pieces of iron take up the position figured. That the ends nearest N are of unlike polarity to N is shown by the attraction between them and N."

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Now, although the explanation given and hitherto agreed to by almost every writer is of great antiquity, it is absolutely incorrect. Writers have followed each other like sheep, and we do not hesitate to say that not one of those who have quoted or given this explanation ever stopped to consider its correctness. There is no attraction and there is no repulsion between the ends of A and B. They simply arrange themselves in the direction of the lines of force of the magnetic circuit. They have no influence the one on the other, as can easily be proved—thus:

Take B away and only have A remaining. As soon as it is brought within the influence of the powerful permanent magnet, as explained above, it takes up the position shown by the full lines. There can be no influence from B, because B is not there. A takes up the position shown by the full lines, because it is under the directive action of the lines of force of the magnet. Similarly, take A away and let B remain. Under the influence of the magnet, B takes up the position shown by the full lines, and for the same reason. Is it not superfluous to bring in the idea of attraction and repulsion upon one another when the position taken is due to the directive action of the lines of force of the magnet? There are no mutual attractions or repulsions between A and B, and no other actions than between any two pieces of the magnet itself similarly placed. A and B, when constrained as in the experiment, take up a position in which as many lines of force traverse the pieces of iron as possible; if unconstrained, they would close up to the magnet, the tendency being, as is well known and understood by Prof. Walmsley, to shorten the magnetic circuit. Numerous experiments are reproduced in books year after year, and by author after author, with a totally incorrect explanation, which shows that "human nature is human nature," after all, and most of us are at times too lazy to think. At any rate, we hope to have knocked the bottom out of this particular explanation, or to be shown that the experiment suggested by us is wrong. We are pretty sure that Prof. Walmsley will agree with us, otherwise it will be difficult for him to reconcile his explanation of the action of the magnetised needle, page 132, with the description on page 100. The remaining part of this chapter is for the most part excellent. In fact, wherever Prof. Walmsley is condensing, summarising, or explaining the facts and theories propounded since the birth of the applications of electricity to lighting, power transmission, telegraphy, or telephony, he is at his best. These facts and theories are at his fingers' ends, and although we may not always agree with the latter, there is no doubt about the author's mastery of the subject or of the admirable and simple way in which he expounds it. This chapter on magnetism should be read and studied attentively. But our space is rapidly running out, and we have only referred to four chapters. The following chapter relates to the thermal production of the current, and concludes Part I. of the book. Part II. deals with the "Laws of the Electric Current," commencing with the discussion of conduction, then of chemical and thermal action; followed by the laws of magnetic action and a long, carefully written chapter (IX.) on electrical measurements. The larger part of these chapters is necessarily not new, but whatever is said is well put. We next come to the discussion of alternate currents, and here again the author is at his best. It is a modern subject, and we know of no better descriptive summary in any text-book than this of Prof. Walmsley. Part IV., commencing with Chapter XI., and consisting of four chapters, is intensely practical, dealing as it does with the industrial applications of electricity: first, the applications of the chemical effect; secondly, of the thermal effect; thirdly, of the magnetic effect; and, lastly, of the transmission of power. Here, of course, we get information upon electrolytic work, upon lighting, upon telegraphy and telephony, and upon transmission. We should like to have dealt at some length with some of the paragraphs, but on the whole we think the author has done well both in selection and in rejection. The illustrations are numerous and good. Indeed, the book is not only a credit to the author, but also to the publishers, and we trust will find its way into the hands of every student.

LONDON COUNTY COUNCIL ELECTION.

VOTE FOR THOSE WHO SUPPORT MANUFACTURERS AND CONTRACTORS.

The County Council election will take place to-morrow (Saturday), and don't you forget it. A few words on the subject of the election without entering into party questions may be opportune. The contest between the "Moderates" and the "Progressives" will be very keen, but bear in mind one important fact. The L.C.C. is endeavouring to dispense with the services of contractors in every possible way. It has started operations in the direction of sewering, building, road-making, painting, and decorating, etc., and the reports of the Works Committee presented to the Council show that the work already carried out by them has cost from 25 to as much as 50 per cent. more than either the estimated expenditure or the amounts at which contractors had previously tendered. In fact, the reading of the reports is not a pleasant thing for either ratepayers or contractors. This is the policy of the "Progressives." But they do not mean to stop at this stage. They intend to commence business as suppliers of water and gas, and, for that matter, the electric light sooner or later; as pawnbrokers, watchmakers, cobblers, bakers, butchers, and Lord Dundreary knows what. The L.C.C. harasses the electric lighting companies in the Metropolis by its pettifogging interference with underground mains and transformer-chambers, wants to swallow the City, and absorb the Board of Trade. This is the line of the "Progressives." Does it not strike you as rather hard upon supply companies that committees having no practical knowledge of the applications of electricity should be permitted to inflict their unwelcome attentions upon them? Does it not also occur to your mind that in time the L.C.C. will compete with electrical contractors in the carrying out of installation work, or that it will establish its own works and become a full-blown contractor for installations in its own—or rather the ratepayers'—buildings, which are sure to become very numerous at no distant date? If you have followed this argument—remembering that it is the "Progressives" who propose to impede your progress or take your business from you—you will know which man to vote for to-morrow. Vote for the man who will not allow, if he can help it, the Council to become a universal provider, but will respect the rights of manufacturing and contracting firms. Vote early, and never mind politics.

COMBINED ELECTRIC LIGHT AND WATER WORKS.

A rather interesting departure, which deserves special consideration now that local government has been divided and sub divided by the establishment of district and parish councils, with in many cases control over limited areas with small population, has been made at St. Lazarus, near Posen, Germany. The town has some 3,000 inhabitants, and the novelty consists in the combination of electric and water works with excellent results. Having discovered by means of boring operations that there was plenty of water in the subsoil, the local authority thought fit to ask for tenders for combined works of the nature indicated, the result being that the Helios Company, of Cologne-Ehrenfeld, were entrusted with the contract. The installation, as described recently by Mr. Luhn, of Berlin, to the Electrotechnical Society of Cologne, comprises four sections—the boiler-house, engine-room, pumping shaft, and accumulator-room. The boiler-house contains two Cornish boilers fitted with Galloway tubes and working at 90lb. pressure. One boiler is sufficient for the operation of the electrical and pumping plant, the other being kept as reserve. Space is available for the accommodation of a third boiler which is to be put down this spring. A heater is provided for heating the feed water, which is supplied to the boilers by a Worthington pump. Near the

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boiler-house is situated the engine-room, in the corner of which is the pumping shaft, 20ft. deep and 17ft. in diameter. Two pumps are arranged at the bottom of this shaft. One is a compound steam-pump, whilst the other pump is driven by an electric motor by means of toothed gearing. The engine-room contains a 50-h.p. steam-engine, running at 190 revolutions, and driving a dynamo by belt. Two air-compressors operated by electricity are arranged on each side of the pumping shaft, the object of these being to increase the pressure of the air contained in two reservoirs. The accumulator-room contains a battery of 136 cells capable of supplying 200 16-c.p. lamps for seven hours. A feeder is carried from the generating station to the distributing centre, where the mains are laid on the three-wire system for private consumers, whilst a separate circuit is provided for the street arc lamps. All the conductors are carried overhead on porcelain insulators fixed to wooden posts 26ft. high. The operation of the station is as follows: During the day, when the consumption of water is comparatively great, the battery is charged, and the demand for water is met by the steam-pump. When the charging of the battery has been accomplished, and in case in the morning before firing up a greater demand for water should arise, the work is carried on by the electric pump with the assistance of the battery. At twilight the current is supplied by the dynamo, and at 11 p.m., according as the street arc lamps are switched off, the machinery is shut down and the battery takes over the supply. In the case of a fire breaking out in the town the electric pump and one of the compressors are brought into use, this being regarded as of great importance. The automatic arrangements adopted throughout the works have reduced the number of attendants, only one engineer and one boiler attendant being required. The disposition of the station has rendered it possible to supply electrical energy at the rate of 3¾ per unit. Another installation on the same plan has been carried out at the neighbouring town of Wilda.

ELECTRICITY AS APPLIED TO MINING.*

BY G. S. CORLETT, MEMBER OF COUNCIL.

Electricity has been extensively used in mining operations, and the cases in which it is so applied are rapidly increasing, so much so that it seems beyond all doubt that in the near future electric mining work will form one of the important branches of our business. I therefore feel no apology is necessary for bringing this subject before the notice of the members of this society. It is, of course, impossible for me to deal at all fully with the different branches of the subject in the time at my disposal this evening, but I wish to look briefly at what has been done up to the present and then consider somewhat in detail certain points that seem to me important. Electricity has been used in mines for (1) signalling, (2) telephones, (3) blasting, (4) lighting, (5) transmission of power.

Signalling.

So far as I have been able to ascertain, electric signals were introduced into some Yorkshire collieries about 20 years ago, and have since been extensively adopted. It would be very interesting to trace the various steps by which this system of communication has gradually been worked up to its present state—how the bichromate battery gave way to the Leclanché, the staples carrying the wires were replaced by insulators and the mechanically good bells of to-day, mounted usually in cast-iron cases, were evolved from the flimsy contrivances called by courtesy "electric bells." The arrangement of the apparatus is now so well known that a very brief description of the simplest form of signalling—viz., engine plane signalling—will suffice. In the engine-house is fixed a powerful bell with a 6in. or 8in. gong, a battery of Leclanché cells, and a plug switch. Along the roadways two galvanised iron wires are tightly strained on small bobbin insulators, and very securely bound on these insulators in the usual manner. At the distant end is placed a strong ringing key. Signals can be given by means of this key or by pressing the wires together at any point on the roadway. The size of iron wire varies from No. 8 to No. 11. The size of the bells, whether of the single-stroke or trembler pattern, is usually determined by the colliery manager. A plug switch is necessary, so that at night and other times when the signal may not be required the battery may be disconnected and leakage prevented. In most cases underground moisture is to be found at some parts of the roadway. The leakage circuits so caused are a constant strain on the battery, and consequently tend to break it down. Any number of bells can be fixed at various points to ring in any desired manner.

The present Coal Mines Act provides that signals must be arranged to ring in both directions—that is, a bell at each end. The advantage of electric signalling for mines is the speed at which signals can be transmitted over any distance. For example, in some of the Durham collieries, where the roadways extend for four miles from the shaft, signalling by the old "rapper" method often involved three or four men stationed at different parts of the roadways to transmit the signals forward. With the electric method, of course it is just as easy to signal four miles as 100 yards. This speed in signalling also tends very largely to safety in working. In case of accident, the haulage rope carrying loaded trucks can be stopped by pressing the wires at any point along the roadway, and in my own experience this has been directly responsible for saving several workmen's lives. There is the further advantage that the attendant at each station knows by the signal where the train is starting from or proceeding to, as the case may be. This system of underground communication has now been extensively adopted by collieries all over the country, perhaps more particularly in South Wales, and so little difficulty occurs in the installation and maintenance of this apparatus that most collieries manage this work without any outside electrical assistance.

Telephony.

Telephones have also been used very largely for surface work for communicating with the various departments, but only to a limited extent below ground. So many collieries have electric signal wires running into the workings; and as it is such a simple and inexpensive matter to attach telephones to the signal wires, it is surprising that more use has not been made of these instruments for underground work. Pocket telephones—that is, a small case containing a receiver and a short length of flexible wire for attachment to the iron wires—are also most useful, but comparatively few collieries have them. Where telephones have been adopted the saving of time has been enormous, and the convenience very much greater than was expected.

Blasting.

Following the strong recommendation, almost amounting to an instruction, of her Majesty's Inspector of Mines, most collieries have now adopted the electrical method of shot-firing. Shot-firing in mines has been the cause of numerous accidents occasioning in too many instances wholesale destruction of life, so that the subject deserves some consideration at our hands. I do not wish to say that the sad accidents which have occurred were due even indirectly to electricity. There has been even in this small branch of electrical work a battle between high and low tension. High tension was adopted first, but is now being gradually replaced by low-tension apparatus. Many important advantages are possessed by the latter, and I think in the near future high-tension exploders will be very little used. Exploders are small magneto machines with a simple shuttle armature which is wound with fine wire for high tension and comparatively coarse for low tension. One end of the armature coil is connected to the frame and the other led through the spindle and an insulated ebonite bush to a contact. In the high-tension exploders this ebonite bush is one of the most frequent causes of failure. Dampness is usually unavoidable, and as this ebonite bush is necessarily small, breakdowns are frequent. I have had several hundreds sent to me for repairs with this fault alone. This is a difficulty which should be easily overcome. At the same time it does not occur in low tension.

Detonators are now being manufactured of a fairly uniform quality, but until recently enormous variations occurred. For example, one lot I tested about 10 years ago required current to fire them at from 2 to 80 volts, and within the last two years I have found a number of so called high-tension detonators requiring from 300 to 400 volts, although 30 to 40 volts may safely be taken as the average pressure required. High-tension detonators are fired by means of a spark passing across the ends of the two wires inside the copper cap of ¼in. diameter. Low-tension are similar in appearance, but the ends of the above wires referred to are joined by a thin piece of platinum wire, which is heated by the current. From a manufacturing point of view I think the low-tension detonators are simpler, and, so far as my own tests go, are of a much more uniform quality. It seems to me extremely difficult to ensure that the distance between the wires in a high-tension detonator should be always uniform, but the most important advantage possessed by low-tension apparatus is that each detonator can be easily tested before use; I know of no test which can be applied to high-tension detonators, and as mis-shots are very costly in themselves and also a source of danger, this advantage cannot be too strongly insisted upon. This class of apparatus is generally used for firing some of the various high explosives, which need not be described further than the remark that their name usually ends in "ite."

* Paper read before the Northern Society of Electrical Engineers.

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Lighting.

One of the earliest attempts at colliery lighting was at the Earnock Colliery in Glasgow, about 14 years ago, and I believe the plant worked very successfully for some time. The first colliery lighting job that I have any personal knowledge of was at one of the Durham pits. This was completed in or about the year 1882, and worked for a number of years. The dynamo was of the old B Gramme type with a wooden hub, series-wound field magnets, and coupled in parallel, supplying current for about 50 Swan lamps of the type then called 20 c.p. The wiring was hardly done in modern style. It is true that the wires were run in casing—the casing had only one groove, which was big enough for all wires. Fuses were entirely absent, the lampholders were of the original Swan spiral spring type, and I think switches were considered altogether unnecessary; the engine stop valve had also to do duty for the main switch. A Paterson and Cooper permanent magnet voltmeter with a loose keeper was also fixed.

It is unnecessary to describe in detail a colliery lighting plant; were I to attempt to do so my most grave and learned audience might think I had written them down as first year's students, but one or two special points are perhaps worthy of more than a passing remark. Most collieries have a fan engine with a large surplus of power, and it is often suggested that this could be used for dynamo driving, but I think that there are very few cases in which it is advisable to do this. The average speed of a fan engine may be taken at 50, and of a dynamo at 1,000 revolutions, or a 20 to 1 ratio. This involves a counter-shaft and fast and loose pulley, or a friction clutch. This gearing, with the additional belting required, often costs almost as much as a small engine, and is not so satisfactory. Five to 10 per cent. variation in the speed of a fan is not uncommon, but this variation is far too great for electric lighting work. Again, there is the uncomfortable feeling of depending on one engine for light and ventilation. I therefore think that the best arrangement is to drive the dynamo with a separate engine. Usually there is space in the fan engine-house to receive an engine and dynamo, and a more suitable place could hardly be found. The man is constantly in attendance, and is, as a rule, not overworked, and can therefore do all that is necessary for the electric light plant. The steam consumption of a colliery electric light engine need not, as a rule, be considered, and an ordinary belt-driven engine seems to answer the purpose. I have found small vertical engines running at from 200 to 250 revolutions a very satisfactory type.

The dynamo should be compound wound for 100 or 110 volts, and should always have a fair margin for extensions, as these are very likely to arise. In plants for surface lighting only, the dynamo usually runs from dusk to daylight, and from 6 p.m. to 6 a.m. is very lightly loaded. During these hours the steam consumption per unit generated is probably enormous from a central-station man's point of view, but at night there is plenty of steam to spare at a colliery, and I do not think, unless in some special cases, it would pay to lay down a small set of plant for the light load. As the electric lighting plant at a colliery has to stand a considerable amount of rough usage, it follows that the wiring should be particularly well done and the highest quality of material and workmanship employed. The advantage of distributing the lighting from certain points at which the switches and fuses are grouped, is perhaps more apparent in this class of work than in any other. Alterations to certain sections of the plant, such as screening arrangements, are constantly being carried out and branch circuits have to be removed and refixed, and not infrequently the wires of the adjacent circuits are damaged by these alterations.

In almost all the places the lamps should be enclosed in very strong fittings, absolutely dust-proof, and with a thick outer glass, which in some instances must be protected by a stout wire guard. In this district the screening and cleaning arrangements are undoubtedly the most important part of a colliery from an electric lighting point of view. A liberal amount of light should always be provided, so that when the glasses become a little dusty, as is just possible, there may still be sufficient light to detect the impurities of the coal. No general rule as to the amount of light to be provided can be laid down, as the screening arrangements vary so largely and also the quality of coal that has to be dealt with. In South Wales, for instance, very little coal screening or picking is required, while in Leicestershire house coal collieries, the small wagons from the mine are drawn into a special shed for the purpose and the best pieces are carefully selected and packed by hand in the railway wagons adjoining. Between these two extremes there is almost every possible variation, so that each individual case has to be dealt with on its own merits.

In addition to the surface lighting arrangements of collieries, electricity has also been extensively used underground for lighting the main roads, engine-houses, etc., close to the bottom of the shaft. The same remarks as to fittings, etc., apply with equal, if not greater, force underground. Where the shafts are comparatively shallow and the number of lamps is small, the underground lighting can easily be effected by a cable from the surface installation led down the shaft, but where, as in this district, 600 yards is quite an ordinary depth for a colliery shaft, and 100 16-c.p. lamps or the equivalent have to be provided, the cost of such a cable becomes a very heavy item. The conditions of underground lighting may be briefly summarised thus: The whole of the lighting is required during the day, but at night only a few lamps at each pit bottom or mouthing are used. During repairs, certain sections of the underground lighting may also be wanted during the night. These conditions imply that the best arrangement is to have a cable connected with the surface installation sufficiently large to supply the whole of the lighting with only a small loss, say four volts, and to use lamps of the same voltage as on the surface. To take a case which may be considered an average one, for a shaft 600 yards deep, 25 amperes will be required at the bottom with three volts loss; the cable will be $^{37}/_{13}$ size, and allowing 1,300 yards of 2,000 megohms vulcanised rubber will cost £342.

Volts lost.	Cable.	£
3	$^{37}/_{13}$	342
4	$^{19}/_{11}$	310
10	$^{19}/_{15}$	119

If four volts, the figures will be $^{19}/_{11}$ and £310. In addition to these figures, there will, of course, be the cost of specially strong casing, and the fixing thereof, as well as the lamps and wiring underground. Taking the cost of the latter at 30s. per lamp, it will be seen that the total capital outlay required for 50 lamps will be £425. This is a fairly large sum, and owing to the present state of the coal trade colliery managers are not inclined to lay it out in such work. It is, of course, possible to provide for a larger loss, say, of 10 volts in the shaft cable, and use, say, 110-volt lamps on the surface and 100-volt lamps underground; the cable would then be $^{19}/_{15}$ and cost £119. Assuming that the cables are provided for a 10-volt loss at full load, and that the lamps required all night are only 20 per cent. of the full load, it follows, of course, that when these lamps are burning the volts at the pit bottom will be 108, but as this pressure would very soon destroy the lamps it is necessary to either switch in a resistance or to wire them in duplicate—one set for 110 and the other for 100 volts. There is the further inconvenience that the other lights cannot be used at all unless almost the whole lot are switched on.

There are two other alternatives open: first, to lay down a separate engine and dynamo at the pit bottom, but this is generally impracticable; second, is to fix a separate dynamo to give 220 volts and couple the lamps two in series underground. This will effect a very large saving in the cables. In the case previously referred to with the same percentage of loss, the sizes of cables would be as follows:

6 volts loss	$^{19}/_{15}$	cost £119
8 ,, ,,	$^{19}/_{16}$	,, 96
20 ,, ,,	$^{19}/_{20}$	,, 45

Usually it would also be practicable to allow the 20-volt loss, as during the night dynamo volts could be lowered by a resistance in the shunt. It seems to me that for fairly large underground installations it would pay to adopt this 220-volt arrangement, in spite of the fact that two dynamos would be running all through the night at extremely light loads—one for the surface and one for the underground. Again, it is quite an open question whether vulcanised rubber enclosed in wood casing is the most suitable form of conductor for shaft work, although speaking from my own experience I have had most excellent results from this quality of cable. There are, however, various other types of insulation and protection, such as lead covered and armoured, which certainly to a colliery engineer have the appearance of mechanical strength. They are, however, very heavy, and sometimes considerable difficulty arises through not properly securing them to the sides of the shaft. This type generally costs more money than vulcanised rubber, but in my opinion it is certainly very much open to question whether it makes a better job. Where cables of a fairly good size have to be carried along the roadways of a mine, then I think it best to adopt the armoured type. In a paper of this sort I scarcely think it fair to mention the names of the makers of different kinds of cable. Remarks on the merits or demerits of individual firms' productions would only tend to ill-feeling.

The question of providing suitable hand-lamps for miners is one that has occupied electrical engineers' attention for a long time, and although very much has been done in the way of experiment, and very many different types of lamps have been brought out, yet up to the present I know of none which I could with any confidence recommend to a colliery engineer to place in the hands of his workmen generally. For some of the officials and for certain special purposes, underground portable electric lamps fitted with accumulators can now be obtained which work fairly well if the instructions as to charging are carefully attended to, and the lamp itself is kept in a vertical position, but should there be a little carelessness on either of these points, trouble and annoyance immediately result. Another very great difficulty is that up to the present no practical apparatus has been devised which can be attached to such lamps to indicate the presence of gas.

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Transmission of Power.

Mining engineers have for some time past been considering the possibilities of electricity as a means of transmitting power in their mines. A certain amount of work has been done, for the most part successful, but excepting in a few cases the plants installed have been of small size and of somewhat experimental character. I mean experimental more from a mining engineer's point of view than that the electrical machines were of an unfinished or imperfect character, or, in other words, that the colliery manager was feeling his way as far as electricity was concerned. Colliery managers, it must be remembered, are directly responsible for the lives of their employés, and not unnaturally looked with some doubt upon the new power, especially since every failure was by interested parties brought into prominence. Then the widely incorrect statements made by electrical men have done much to deter electrical work. Colliery managers have been assured that the combined efficiency of engine, dynamo, cable, and driven machinery would be 90 per cent. Such a statement is of course absurd, but its very absurdity is prejudicial to our interests, as the colliery manager naturally concludes that we know nothing of our business. Again, some electrical engineers have laid down power plant in mines of a very inferior character. They have not taken the trouble to ascertain the difficulties of working, the rough usage, the scanty attention, and the large increase of power occasionally demanded. The result has been constant breakdowns with the consequent expense and annoyance. Such cases cannot be too strongly condemned; it is the whole trade which suffers, and not the individual that does the job. On the other hand, however, much good work has been done. One of the earliest, if not the first, power plant was put in by Mr. Frank Brain, in the year 1882, at his Trafalgar Colliery, and this I understand is still at work, but has since been considerably extended.

Electricity has been applied to pumping, hauling (by fixed motors and by locomotives), coal-cutting, fandriving, and drilling. A full consideration of the problems involved in any one of these sections would be quite sufficient for a separate and elaborate paper; it is, therefore, obviously impossible for me to describe each in detail, but there are certain points common to all plants which may well be commented on. Electrical engineers who undertake this class of work are pretty well agreed that the current should be supplied at a constant pressure, and I think 500 volts a very suitable standard to adopt. This will, I think, be found in practice sufficiently high to make it commercially practicable to transmit power to the ordinary distances of a mine without an extravagant outlay in cable, yet not so high as to cause a dangerous shock, nor too high for the very small motors that are occasionally required for pumping small quantities of water. It must be remembered that one of the great advantages of electrical power transmission in mines is its flexibility. It can be as readily applied to small powers as to large, and if the volts are raised much above the limit I have suggested, practical difficulties will arise in the manufacture of motors under 2 h.p. These small motors are really required in practical work. I have one or two motors working underground driving pumps which are only taking ¾ e.h.p.

The quality and sizes of cables must be almost entirely regulated by the circumstances of the particular case. For shaft work I have found good vulcanised cables last remarkably well, while for the roadways of the mines, where heavy currents are required, cable insulated with bitumen or one of the resinous compounds protected with a heavy steel armouring, and laid directly in the ground, makes an admirable job. I think in all cases it is advisable to have insulated lead and returns, although I have myself one job where an uninsulated return is used, though with only moderately satisfactory results. The return consisted at first of a steel-wire rope, but on account of its very high resistance, presumably at the joints and splices, bare copper wires were used to increase the conductivity. In a mine it is impossible to insulate such a conductor, and, generally speaking, I think it pays to spend the additional capital required and provide an insulated return circuit. For most of the operations required in mining, a series-wound motor is the most suitable. For pumping and hauling it is an absolute necessity, as an enormous torque is required to start the load. In laying down any system of power plant it is extremely difficult to obtain from the colliery engineer reliable figures as to the power required. Speaking from a somewhat intimate connection with colliery engineers extending some 10 years back, I am inclined to think that a very large number of them never trouble to ascertain what power is being expended on certain operations. For instance, if pumping plant by ropes or compressed air is being laid down, care is taken that there is an ample margin of power, and so long as the work is being done without a breakdown the colliery engineer does not measure the exact horse-power required for dealing with this particular quantity of water. Although it is a comparatively simple matter to determine the theoretical power required, the actual power is often a very much larger amount.

In pumping work, for instance, the friction of the pump and its gearing does not vary in any fixed proportion to the total horse-power. A moment's consideration will show that the friction of the pump itself will be about the same whether the pump is worked against 50ft. or 500ft. of head. Pipe friction is also an item that requires careful consideration. In the majority of cases electrical pumping work at a colliery is for a fairly large quantity of water on a comparatively small head, and the friction in the pipes may absorb quite as much power as the raising of the water. In one instance under my own charge the pipe friction is just double the power required to raise the water. In calculating the pipe friction I have used the following rule, which has the advantage of being easily remembered, and, as far as I have been able to check it, is very correct. It is due to Prof. Merivale, of Newcastle-on-Tyne, and is—

$$\frac{G^2 L}{(3d)^5} = H;$$

where G = gallons per minute;
L = length of pipe, in yards;
d = diameter of pipe, in inches;
H = head due to friction.

In haulage work the amount to be allowed for friction is also very variable. On a wet road which is badly kept, with rails allowed to get slightly out of gauge or not free from small pieces of stone or coal, the power due to friction is enormous as compared with a dry and well-kept roadway. Again, provision has to be made for the additional loads that may be put on the plant. For instance, in an endless-rope haulage system, it often happens that the rope is for short periods much more heavily loaded than is usual. The motor must be big enough to respond to this demand; indeed, in all mining work an ample margin of power is necessary. The only haulage in a colliery in this country by an electric locomotive that I know of was installed at a Yorkshire pit. A rope was laid along the roadway and secured at each end; in front of the train was a special trolley carrying a motor driving a clip pulley. The rope passed round this pulley, and the train was, so to speak, wound along. This system is not likely to be generally adopted. Another interesting case involving the use of electric locos. is at the Greenside lead mines, Ullswater. A full description of the plant will be found in the *Transactions* of the Federated Institute. In each of these cases the current is taken from overhead conductors by a sliding contact. There are a large number of collieries using machinery of various kinds that might profitably be driven by motors, and new applications are constantly being made in this direction—such as the replacement of wire-rope pumping plant or compressed-air machinery by electric plant.

There is some difficulty in describing what has been done in coal-cutting; a considerable amount of work has been done by the Coal-Cutting Corporation, but I hear various reports as to the success of the apparatus, and as I have never been able to obtain permission to inspect the plant, I am unable to give any details of its performance. There is apparently no doubt that there is a large future for a practical coal-cutter, but I think such a machine has yet to be designed; certainly I do not know of one fulfilling all the requirements. So far I have not alluded to the risk of explosions from gas. This is one of the most important problems of all, and I think that its satisfactory solution will be found in alternating-current apparatus, probably di- or tri-phase type. So far as I know, these have not been used in England, but their simplicity and the absence of brushes and commutators seems to point them out as the ideal mining motors of the future. The difficulty about low starting torque will no doubt be speedily overcome. Certain so-called safety devices have been devised for continuous-current apparatus, the most important of which probably are the steel-clad motor of Mavor and Coulson, in which the whole motor is enclosed in a steel case; the Goolden arrangement, in which the armature is enclosed; and the Davis-Stoke's method, in which the commutator is enclosed—*i.e.*, the brushes bear on the inner periphery, and the whole enclosed by a revolving ring. The first method seems undoubtedly the best, though in all I fancy the skill of the attendants bears some proportion to the safety. It is hoped that these notes, which have been hurriedly put together, may be of some service to the members, and that some of the points briefly touched upon may be fully discussed.

Discussion.

Mr. Henry Edmunds (the chairman) said that the paper covered a very wide field. There were one or two questions he would like to ask. He would like to know why the use of electricity in mining had been limited to continuous currents, and nothing said of transformers. He thought the employment of transformers would get over most of the difficulties in regard to the loss of voltage in transmission to the bottom of the pit shaft or along the galleries. The speaker then drew attention to the short note at the end of the paper, to the effect that the risk of explosions from gas might be obviated by the use of alternating-current apparatus, probably of the triphase type. Some

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three years ago he was at the Frankfort Exhibition, and saw the experiments there in connection with the "Drehstrom" apparatus, exhibited by Prof. Dobrowolsky. He (the chairman) had in London a motor on that system, in which there were no brushes, which could be started electrically at full load, and which could be reversed and run in either direction. The machine was perfectly sparkless. It was interesting to note that such a motor had been evolved so peculiarly suited for mining work, although it was very little known as yet. The incandescent lamp was, of course, the safest illuminant in mines or wherever there might be an explosive atmosphere. The only difficulties were those arising from switches and fuses and cut-outs, which might spark, and thus cause the spark to come into momentary contact with the atmosphere. Mr. Corlett had said something about a difficulty arising from the fact that the ordinary incandescent lamp gave no indication of firedamp. Up to the present no practical device had been invented, but he (the speaker) would like to know what useful purpose would be served by such a device. The ordinary Davy lamp gave warning of the presence of gas owing to its construction, but surely it was not necessary to fit every miner's lamp with a gas indicator. There were many other pieces of apparatus which indicated the condition of the atmosphere with greater or less success, and the mining engineer ought not to have any difficulty in learning the state of the mine.

Mr. J. H. Rider observed that in his remarks the president had mentioned that in alternating currents was possibly found the solution of many of the difficulties met with in pit work. He quite agreed with this, and intended to have spoken on the same matter himself. Mr. Corlett had referred to vulcanised rubber cables as being suitable for use in pit shafts. He (the speaker) remembered a case, six or seven years ago, with similar cables in a Yorkshire pit, where the cable was eaten right through in a fortnight with what was found to be some saline solution coming out of the sides of the shaft. A lead-covered cable was afterwards used. He enquired whether Mr. Corlett had had any similar experience.

Mr. Fawcus said that in giving the figures of the cost of various sized cables the author had evidently never contemplated the possibility of using lamps of a voltage of from 200 to 250, or he could have halved these costs. Lamps of these high voltages could now be procured commercially; they had been used for some time successfully on the Continent where the candle-power was not less than 16 in the case of the 200 volt-lamps, and 25 in the case of the 250-volt lamps. The speaker also agreed with the remarks of Mr Rider that there was no reason why alternating currents should not be used, at all events for the lighting of coal-mines. There was also the alternative of using a pressure of 300 or 400 volts and running the lamps in series, a system adopted with success in many cases overground.

Mr. C. H. Wordingham expressed surprise that so little reference was made in the paper to sparking, which was one of the most important obstacles to the introduction of electricity into mines. He suggested that danger might arise from the bare wires used for signalling by sparking when contact was made, and also by accidental contacts causing unintended signals to be sent. He enquired whether a non-sparking cable brought out some two or three years ago, had been practically employed. The main cable was stranded over an insulated thin wire coiled within it, the two being connected together at both ends, and fuses proportionate to their sizes being inserted at the surface end. If the main cable broke, the thin wire uncoiled and remained intact, carrying the current until the fuse went at the surface, rupturing the circuit where the spark could do no harm. As regarded the author's suggestion of using a 100-volt and a 220-volt machine, he enquired why the surface lamps could not be put two in series as well as those below. The whole of Whitehaven was lighted in that way with most satisfactory results. Another way he might suggest of overcoming the difficulty of the 100-volt drop would be to put a few cells in series with the lamps at light loads to give a back pressure; these could be usefully employed when charged for bell or detonating work. He asked why the cables were not run down the shaft in an iron pipe, instead of in wooden casing. This would be much more suitable, and would prevent their being damaged by saline matter in the way referred to by a previous speaker.

Dr. Keith, having made some remarks upon electricity as used in mines in the United States, asked the author if in the formula shown the H due to pipe friction was in yards or feet He said that pipe friction was very much increased when there were many turns, bends, or elbows, which proved a very serious matter, adding very much to the head. He would like to know if Mr. Corlett had any formula for calculating that. With reference to small motors in mines, from his own experience he had known of motors running which were under 2 h.p, and even as low as ½ h.p. or ¼ h.p.

Mr. Geo. J. Somerville gave some particulars about the Earnock Colliery mentioned in the paper. Along with Mr. A R. Bennett, he was engaged at that installation in 1881. The colliery was situated about two miles from Hamilton, in the county of Lanarkshire. The dynamo was of the Gramme type and was fixed above ground. It was not driven by a special engine. The leads were taken down the shaft, which was 720ft. deep. The light was supplied by the old style of Swan lamp, and switches were fitted for each set of lights. Double-pole mercury switches, specially designed to avoid danger from sparking, were used underground. Portable miners' lamps were also used at the headings, which were about 440 yards from the foot of the shaft.

Mr. Ed. W. Cowan said that he would like to suggest another way of engineering the lighting of the roadway at the bottom of a deep pit shaft in conjunction with the surface lighting. Some speakers had suggested that an alternating current might be used, and he was about to briefly describe a way of applying an alternating current to that purpose. The alternating current might be obtained from an ordinary continuous-current dynamo, such as would be used for the surface lighting, by simply fixing two narrow collecting rings on the commutator and making electrical connection between them and opposite bars of the commutator. One pair of brushes would then supply continuous current for the surface lighting and a second pair supply alternating current to the pit shaft. At the top of the shaft a transformer would be fixed transforming the 70 volts of the alternating current up to, say, 1,000 volts. He would carry the supply to the pit bottom by means of a $^{7}/_{20}$ lead-covered concentric cable, cleated to the woodwork in the shaft. At the bottom the current would be transformed down again to the pressure required for the lamps. If they compared the cost of this arrangement with that proposed in the paper, they would find that there would be a great saving. He made it out to be £147 against £350 for the same "drop" of 4 per cent. and the same output. It was true that there was some loss of efficiency due to the iron loss in the transformers. In the case taken it would amount to 198 watts, say, three 60-watt lamps, but this was not a serious matter where coal was so cheap. There were two objections which might be raised—one was the fluctuation in the light due to the low frequency necessarily resulting from using a two pole machine as generator, but a frequency of 20 or 25 would certainly cause no inconvenience whatever in a mine. The other objection he referred to was the danger to workmen on account of the high pressure, but he thought that by using a concentric cable and earthing the "outer" there need be no fear on that account. As a further precaution, the end of the primary composing the layers wound round next to the secondary coils should be connected to the earthed outer. The "inner" would then be practically sealed from end to end. He would be glad to know if Mr. Corlett could see any practical objection to that plan.

Mr. C. M. Dorman suggested that as it was still in most instances desirable to use direct rather than alternating currents for both lighting and power transmission in mines, the financial difficulties attending the use of the abnormally long mains therein used could very often be met by the use of motor transformers. He had never yet seen a multiphase-current motor that would respond to the enormous starting torque demanded by underground engineers. He insisted, however, that the important question of the safety of the use of electric currents in fiery mines had been too cursorily dismissed in the paper. The difficulties attending the sparking which always accompanied the opening of a circuit had caused considerable anxiety to those responsible for its safe performance. Firedamp must be absolutely excluded from the box in which the switch was enclosed, otherwise when it became filled with an explosive mixture the arcing of the switch would cause the lid to be blown off, with perhaps disastrous consequences. The actual presence of firedamp in the proximity of the switching apparatus was not the only factor to be feared. The possibility existed that the periodicity of the oscillatory disruptive discharge might be so rapid that the waves radiating from the spark would travel along the ways of the mine until they found therein some metallic arrangement by which they could produce Hertzian sparks. A very small spark would ignite an explosive mixture. Although he was not prepared to specify the exact necessary conditions, it was at any rate within the realms of uncertainty that short waves started perhaps in the switchroom of a central station might travel along inside the iron pipes containing the mains until they met with the necessary syntonic conditions in, say. a manhole, and there cause one of those mysterious explosions lately so prevalent in the streets. It was a well-known fact that not only had the lampholders in the lecture theatre of the University College at Liverpool been short-circuited by waves radiating from a generator emitting electromagnetic waves of very high frequency, and consequently of very short wave lengths, but that arcs had been struck between the carbons of an arc lamp when they were suitably polarised, but not quite in actual contact. Was there one of them prepared to assert that under favourable conditions the opening of a switch in a circuit fed by an alternating source of ordinary frequency, or even by a direct current, might not set up waves radiating from its oscillating arc of such high frequency as to be capable of exciting any syntonic resonator in the vicinity? Mr. Dorman, in a communication to the society, added that it seemed he had not made it quite clear to which waves he had referred. The wave length was of course equal to the ratio of the speed of propagation to the frequency; consequently the waves thrown out from an alternator whose periodicity was 100, would be $186{,}660 \div 100 = 1{,}866$ miles long. But the electric and magnetic waves do not travel together in phase until a distance from the origin of a quarter of a wave-length is reached. Hence the nearest distance from the source at which such action could take place would be $1{,}866 \div 4 = 466$ miles, or as far as Inverness from London. Certain parts of the installation might, however, happen to be so arranged as to capacity and self-induction as to cause an oscillatory spark having a periodicity of perhaps a thousand million per second, and consequently emit radiation of only a foot wave length. It was to these shorter waves that he had referred in his remarks.

Mr. Bally, in reference to the short-circuit that had been produced in the lecture theatre at University College, Liverpool, said that it had been caused by the electromagnetic waves emitted by an exceptionally large oscillator of Hertz pattern acting on a large rectangular circuit of some 70ft. circumference, which was formed by the electric light leads and some stay wires. The striking effects produced by these very rapid disturbances of short wave length would be reproduced only in an exceedingly small degree by the comparatively slow disturbances of enormous wave length

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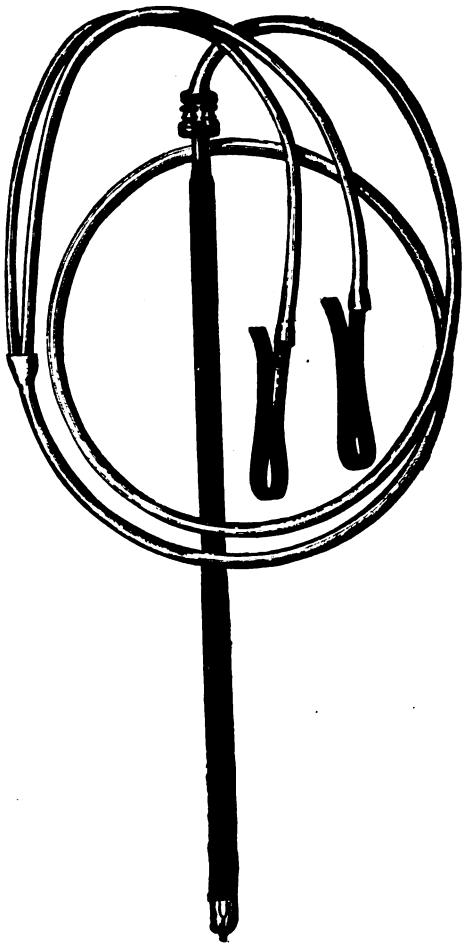
given out by the ordinary alternating current, and hence there was no fear of a similar catastrophe occurring and producing sparks in a coal-mine. He wondered that the dangers of sparks in mines had not been dealt with more fully. An electric spark discharge was one of the favourite ways of exploding mixtures of gases in the laboratory, and one of the points to which most attention was paid by manufacturers of electric mining plant was the elimination of sparking or the careful shielding of the spark, if its production was unavoidable. He thought that the charge against English engineers of slowness in adopting polyphase-current motors was hardly justifiable. Although the efficiency of those motors was fairly good, and some of them would start with a moderate load, no one would claim that they could start with some two or three times the normal load, which was an essential requirement for haulage and traction, and which any good continuous-current series motor could easily manage.

Mr. Corlett, in reply, said he began to read his paper with a lively feeling of failure. Owing to the very short time available for preparing it, it was, of course, impossible to take in detail one particular branch of the subject, and it was therefore considered best to attempt a general sketch of what had been done up to the present in this country. There were important mining installations in Europe and America, and at some future date a description of some of them would be instructive and interesting. The president and others had suggested for underground lighting the use of alternating-current appliances. In one colliery the speaker's firm had put down such a plant, working at 2,000 volts, not so much for the sake of reaching underground workings, but for lighting the owner's residence 1½ miles away. It must be remembered, in the first instance, that at a colliery there were at present no skilled electrical engineers The electric light plant had to be worked by an ordinary engineer of the colliery, and in many cases he was far too busy to devote any personal attention to it. The plant was put down somewhere, and it had to run. In the plant referred to, elaborate measuring instruments were not purchased, and occasional failures occurred on the high-pressure wires. For very large plants, which would warrant a thoroughly high-class man being engaged, no doubt such apparatus would give perfect satisfaction, but for small lighting installations at a colliery trouble and annoyance would probably result. An ordinary plant did not involve more than about 300 lamps of 16 c.p. for any one colliery, and very often only required 60 to 150 lights. One did not see much of alternators of that size at 1,000 volts. Most alternating tests started at 25 kilowatts, and increased up from that, but as a rule they did not come down below it. In reply to Mr. Cowan's suggestion, it was rather surprising to hear how cheaply the cost came out, and that seemed a very easy way of doing it. It was often impracticable to run, say, a 220-volt circuit on the surface to include general offices, cabins, etc., where one light was often required. Then all that work had to go more or less under the control of H.M. inspectors of mines, whose general feeling was apparently against the introduction into mines of high pressures. It was quite true that in his paper the question of sparking had not been dealt with. That was partly because the great proportion of electric transmission work in mines at present had been placed on the main intake—that was to say, on the main road over which fresh air from the surface was passing to all the workings. As the ventilation of mines had lately been generally improved, so that there was a strong current of fresh air all along those roadways, any gas that might possibly be given off was immediately cleared away. It was at the workings themselves as the coal was being moved that bodies of gas were likely to be given off. That was also the reason why the gas-indicating apparatus must be attached to the lamp itself. The roadways were narrow—in some mines 3ft. was a wide and high roadway—and 2ft. was not an exceptional one, the man having to crawl along with the lamp perhaps in his mouth, and might come into a volume of gas and be suffocated before he would have time to get out, unless his lamp indicated the presence of the gas. Gas indicators must be attached to the large proportion of lamps in collieries. In some cases, where a large number of men was working close together under one official, a lamp without a gas indicator might be used by the men themselves. Mr. Fawcus had asked why 200-volt lamps should not be used. He (the author) did not know where to get them of good quality. He had tried (not very recently) lamps up to 130 and 140 volts, which burnt any time from three minutes upwards. If there were lamps of 200 volts, of 16 c.p. or 32 c.p., which had a life of, say, 1,000 hours, and an efficiency of three to four watts, they could be used about collieries very largely, and effect a very considerable saving. Mr. Dorman had mentioned the fact that static charges might be given by alternating current, and had also made some remarks about Hertzian waves, from which it would appear that there would not be much chance of doing any more mining work; but it was comforting to hear from Prof. Baily that collieries were too small for a wave to take any notice of. At the same time, the subject was very interesting, and it was to be hoped that at an early date more information would be laid before the society. Mr. Clirehugh had criticised the suggested standard of 500 volts, considering the severe shock a drawback, but in spite of that the author thought a pressure of 500 volts was useful for every class of mining machinery except, perhaps, coal-cutting, for which possibly 250-300 might be preferable. Mr. Clirehugh had also stated that English engineers had very little idea of what was being done, and instanced a particular installation as a very good job, and was very careful to state that it was done by a foreign firm. It was, however, possible that no English manufacturer had a chance of quoting for the necessary plant. Mr. Wordingham had spoken about a safety cable on rather an extensive job in the county of Durham. Two or three miles of that cable were laid down, but the author had no definite information about its performance. In reply to Mr. Wordingham's suggestion to use iron pipes for the shaft cable, he did not think it would be wise, as it was difficult to get at the cable, and, in addition, its whole weight would be on one support at the top, and with a 600-yard shaft that arrangement would be impracticable. In answer to Dr. Keith, the author stated that the formula gave the head in feet. In conclusion, the author expressed the hope that some other member would take up one section of mining work and read a paper on the subject.

The Chairman said he hoped members would consider Mr. Corlett's suggestion that detailed papers might be read on some of the topics touched upon that night. He asked the meeting to accord a very hearty vote of thanks to Mr. Corlett for his admirable paper.

BATTERY INSPECTION LAMP.

A very useful lamp for utilisation in central stations and private installations where accumulators are put down, has been introduced by the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, E.C. The lamp—the construction of which is represented in the accompanying illustration—is provided with a length of flexible cable, so as to be readily carried from cell to cell for putting into the electrolyte between



the plates of the E.P.S. batteries. It will be readily understood that a lamp of this kind will be found especially useful for inspecting in lead or lead-lined boxes the condition of the plates, which cannot otherwise be easily seen. Besides the flexible connections, the lamp is fitted with springs to grip on to the lead connecting bars of adjacent cells—a four-volt lamp being used. The lamp has already been adopted in central-station work, where it has proved of great utility.

TEMPERATURE ALARM.

In the annexed illustration is shown a new temperature alarm, which has been brought out by Messrs. Naglo Bros., of Berlin. It is claimed that this alarm fulfils all the requirements necessary in such an instrument. Its advantages are simplicity, punctuality, and cheapness. The alarm consists of a compartment which is divided into two unequal parts by means of a flexible division. These are filled with two gases of different expansion, and if the temperature rises the circuit is closed and an alarm is given. This apparatus, which can be adjusted to any desired degree, is exceedingly sensitive, and

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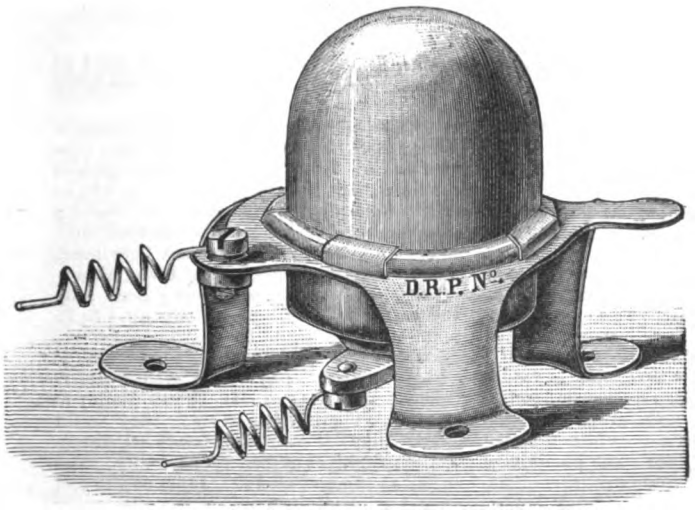
absolutely independent of external air pressure. Its sensitiveness is shown by the fact that it is only necessary to touch the compartment with the palm of the hand or to breathe on it in order to set the bell in motion. It is claimed that by the use of this alarm, which is being introduced in this country by Messrs. J. Bartels and Co., of 25, City-buildings, 23, Old Hall-street, Liverpool, that a fire should have no chance of extension, being announced at its commencement. This apparatus



should highly recommend itself for steamers or sailing vessels with inflammable cargo, and it is also used to advantage on the Continent in factories for raising an alarm in case of the heating of machinery, etc.

ELECTRIC LIGHTING AND TRAMWAY PROVISIONAL ORDERS.

The following is a list, together with the proposed capital expenditure, of the applications for electric lighting provisional orders to be considered during the present session :

Alderley Edge.—To authorise the Alderley Edge Urban District Council to supply electricity within the district. £10,000.

Bath.—To authorise the City of Bath Electricity and Engineering Company, Limited, to supply electricity within the city of Bath. £38,774 already expended.

Battersea.—To authorise the County of London and Brush Provincial Electric Lighting Company, Limited, to supply electricity within the parish of St. Mary, Battersea. £20,000.

Bootle.—To authorise the mayor, aldermen, and burgesses of the borough of Bootle to supply electricity within that borough. £20,000.

Bray (Ireland) Township Improvement Bill.—To authorise the Bray Township Commissioners to supply electric light for public and private purposes.

Brechin.—To authorise the Scottish House-to-House Electricity Company, Limited, to supply electricity within the Royal burgh of Brechin. £20,000.

Carlisle.—To authorise the mayor, aldermen, and citizens of the city of Carlisle to supply electricity within that city. £40,000.

Leigh.—To authorise the Leigh Local Board to supply electricity within the urban sanitary district of Leigh £25 000.

Liverpool.—To authorise the Liverpool Electric Supply Company, Limited, to supply electricity within portions of the city of Liverpool, and of the Local Government district of Toxteth Park. £20,000.

Llandudno.—To authorise the Urban District Council of Llandudno to supply electricity within the urban sanitary district of Llandudno. £14,625.

Luton.—To authorise the mayor, aldermen, and burgesses of the borough of Luton to supply electricity within that borough. £10,000.

Margate.—To authorise the Municipal Electric Light and Power Corporation, Limited, to supply electricity within the municipal borough of Margate. £15,000.

Montrose.—To authorise the Scottish House-to-House Electricity Company, Limited, to supply electricity within the Royal burgh of Montrose. £20,000.

Motherwell.—To authorise the Commissioners of the burgh of Motherwell to supply electricity within that burgh. £12,500.

Newington.—To authorise the County of London and Brush Provincial Electric Lighting Company, Limited, to supply electricity within the parish of St. Mary, Newington. £20,000.

New Windsor.—To authorise the mayor, aldermen, and burgesses of the borough of New Windsor to supply electricity within that borough and the Eton urban district. £18,500.

Notting Hill.—To authorise the Notting Hill Electric Lighting Company, Limited, to supply electricity within a portion of the parish of St. Mary Abbotts, Kensington.

Pontypool.—To authorise the Pontypool Electric Light and Power Company, Limited, to supply electricity within the district of the Pontypool Local Government Board. £6,689.

Prescot, Huyton and Roby, Rainhill, Eccleston and Whiston.—To authorise the British Insulated Wire Company, Limited, to supply electricity within the districts of the Prescot and Huyton and Roby Local Boards ; and the townships of Rainhill, Whiston, and Eccleston. £15,000.

Radcliffe.—To authorise the Radcliffe Urban District Council to supply electricity within the urban sanitary district of Radcliffe. £20,000.

St. Olave's.—To authorise the County of London and Brush Provincial Electric Lighting Company, Limited, to supply electricity within the district of the St. Olave's District Board of Works. £20,000.

Salisbury.—To authorise the Salisbury Electric Light and Supply Company, Limited, to supply electricity within the city of Salisbury. £20,000.

Southampton.—To authorise the Southampton Electric Light and Power Company, Limited, to supply electricity within the county borough of Southampton.

Stirling.—To authorise the Commissioners of the burgh of Stirling to supply electricity within that burgh. £12,000.

Strand District.—To authorise the Charing Cross and Strand Electricity Supply Corporation, Limited, to supply electricity within the district of the Strand District Board of Works. £30,000.

Swindon New Town —To authorise the Swindon New Town Local Board to supply electricity within the urban sanitary district of Swindon New Town. £15,000.

Walthamstow.—To authorise the Walthamstow Local Board to supply electricity within the Local Government district of Walthamstow. £11,000.

Winchester.—To authorise the mayor, aldermen, and citizens of the city of Winchester to supply electricity within that city. £20,000.

Windermere and District.—To authorise the Windermere and District Electricity Supply Company, Limited, to supply electricity within the districts of the urban sanitary authorities for Grasmere, Ambleside, Bowness, Windermere, and Kendal ; the district of the Kendal Union Rural Sanitary Authority ; the districts of the urban sanitary authorities for Ulverston and Grange ; the district of the Ulverston Union Rural Sanitary Authority ; and a portion of the district of the Lancaster Union Rural Sanitary Authority. £50,000.

Worthing.—To authorise the mayor, aldermen, and burgesses of the borough of Worthing to supply electricity within that borough. £27,500.

Tramway Bills and Provisional Orders.

The Dublin United Bill authorises the use of electric powers, and working agreements with the Clontarf Company.

The Leeds Corporation Bill authorises additional tramways ; the use of animal, steam, or any mechanical power ; and power to Corporation to work the tramways.

The London County Bill authorises the County Council to work their tramways, and to agree with other parties as to exercise of running powers.

The London, Deptford, and Greenwich Bill authorises the construction of new tramways ; extends the time for the completion of certain tramways authorised by Acts of 1889 and 1891 ; and sale to County Council and leasing of tramways.

The London Street Bill authorises the company to accept a lease of any tramways acquired or constructed by the London County Council and other local authorities.

The South Shields Corporation Bill authorises the Corporation to construct tramways on a gauge of 3ft. 6in., to be worked by animal, steam, or mechanical power ; running powers over existing tramways ; and power to Corporation to work the tramways.

The Aldershot and Farnborough (Extension) Order authorises the construction of additional tramways in the neighbourhood and suburbs of the camp at Aldershot, and through the town of Aldershot, to be worked by animal, steam, electric, or any mechanical power.

The Carlisle and District Order authorises the construction of tramways in Carlisle and district on a gauge of 4ft. 8½in., to be worked by animal or any mechanical power not being steam power.

The City of Gloucester Order authorises the construction of tramways in Gloucester, and parishes of Upton, Saint Leonard, Hempstead, and Tuffley ; power to work such lines, and the tramways already authorised, by animal, electric, or other mechanical power ; the removal of certain existing tramways.

The Great Yarmouth Order authorises the construction of tramways in the borough on a gauge of 3ft. 6in., to be worked by animal or any mechanical power other than steam.

The Hartlepool Electric Order authorises the construction of tramways in West Hartlepool, on a gauge of 3ft. 6in., to be worked by any mechanical or electric power ; and running powers over lines authorised by Hartlepool Tramways Order, 1883.

The Hartlepools Order authorises and confirms an agreement between Mr. T. Trafford Moyes and Mr. Stephen P. W. d'Alte Sellon, for the transfer of the undertaking to Mr. Sellon ; and the amendment and extension of the Hartlepools Tramways Orders, 1883, 1884, and 1888.

The London, Deptford, and Greenwich Order authorises the construction of tramways in Tooley-street and Parker's-row, to be worked by electric or any mechanical power other than steam.

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The London United Order authorises the construction of tramways in the parishes of Hammersmith and Acton, to be worked (as well as the existing tramways) by animal or by any mechanical power.

The Newcastle-upon-Tyne Corporation Order authorises the working of the existing tramways by cables and ropes, and the borrowing of £130,000.

The Somerton, Keinton-Mandeville, and Castle Cary Order authorises the construction of a deviation tramway in the county of Somerset.

The Wigan and District Order authorises the construction of extension tramways in the districts of the Hindley and Ince-in-Makerfield Local Boards and the borough of Wigan.

TRANSFORMER-CHAMBERS IN LONDON.

The following report of the Highways Committee of the London County Council, presented to the latter on Tuesday, will be read with interest by all concerned in the electric lighting of the Metropolis. It may also be as well to bear in mind that the Mr. A. Bassett Hopkins mentioned in the report is a member of the L.C.C.

Electric Lighting Acts and Orders—Appeals of the County of London and Brush Provincial Electric Lighting Company against decisions of the Council.

We reported on October 23 last that the County of London and Brush Provincial Electric Lighting Company had appealed to the Board of Trade against the Council's disapproval on second idem of the company's proposal in notices dated August 23 and 29, to construct many transformer-chambers of large size under the public streets in St. Luke's, Clerkenwell, and Wandsworth, and we then stated that we were taking the necessary measures to have properly brought before the Board of Trade the Council's objection to the wholesale appropriation of the public thoroughfares for the purposes of private enterprises. The Board of Trade held an enquiry on December 13 and 20 last with reference to the proposed systems of supply under (*a*) County of London (North) Order, 1892; (*b*) Southwark Order, 1892; (*c*) Wandsworth Order, 1892 in respect of all of which the County of London, etc., Company are the undertakers; (*d*) House-to-House Company's Order, 1889; (*e*) Hampstead Order, 1892, and Islington Order, 1892, the respective vestries being the undertakers under the two last orders

At this enquiry the County of London and Brush Provincial Company was represented by Mr. Cripps, Q.C., and the House-to-House Electric Light Supply Company, whose system of supply is similar to that of the County of London Company, was also represented by counsel (Mr. G. A. Scott), and a formidable array of witnesses appeared on their behalf, while the Vestries of Clerkenwell, Hampstead, Islington, Kensington, St. Luke, and St. George's, Southwark, and the Wandsworth District Board were also represented. The Council's case was conducted by Mr. A. Bassett Hopkins, and we are glad to take this opportunity of recording our sense of the value of the services rendered by him in the matter without fee or reward. In view of the eminence of some of the witnesses on the other side, among whom were, we may mention, Sir F. J. Bramwell, Dr. J. A. Fleming, and Dr. Silvanus Thompson, we considered it necessary to engage expert witnesses of some note on behalf of the Council. We therefore gave instructions for Sir Benjamin Baker, Dr. J. Hopkinson, and Mr. Enright, to be retained, and these gentlemen supported the evidence of the Council's engineer. The fees payable to these gentlemen for their services, and some other minor expenses in the matter, amount to about £150.

The Board of Trade has since intimated that, having considered the objections to the proposed systems of supply under the orders above specified, it is not prepared to hold that sufficient reasons have been advanced, either on the ground of public safety or of want of parliamentary sanction, to justify the Board in refusing to approve of a system of supply which involves the use of transformer-chambers under the public streets, but that the user of the streets for the purpose should be limited and the chambers so placed as not unreasonably to interfere with existing underground work; that the Board will approve the system with certain alterations; and that the Board hopes that this decision on the general question will render unnecessary any further action on the appeals lodged by the County of London and Brush Provincial Electric Lighting Company.

We have informed the companies concerned that in connection with any notices for the construction of transformer-chambers full particulars and plans must be supplied showing the exact position to be occupied by, and the internal and external dimensions of, each of the chambers proposed to be constructed, and also the existing works which will be disturbed thereby; and that the Council reserves its right to approve with or without conditions, or to approve the construction of all or any of the chambers referred to in such notices. We recommend (*a*) that the Council do disapprove of the action taken by the Highways Committee with reference to the appeal to the Board of Trade by the County of London and Brush Provincial Electric Lighting Company, and that, subject to an estimate being submitted by the Finance Committee in accordance with the statute, payment be authorised of a sum not exceeding £150 for the fees of the expert witnesses retained and some other incidental expenses in support of the Council's case; (*b*) that the cordial thanks of the Council be given to Mr. A. Bassett Hopkins for the services rendered by him in having so ably conducted the Council's case at the Board of Trade enquiry with reference to the appeal.

COMPANIES' MEETINGS AND REPORTS.

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LIMITED

An ordinary general meeting of this Company was held at Winchester House on Wednesday, Sir David Salomons occupying the chair.

The **Chairman**, in moving the adoption of the report, spoke of the advantages of the electric light, which did not, like gas, condense in the pipes and give a bad light, or freeze up altogether. As in the previous year, there had been very little fog, but an impartial critic would say the Company had given a satisfactory supply, and that the organisation was also in a satisfactory condition. The gross income was now about £114,000. He had previously had to apologise to the ordinary shareholders for not being able to give them dividends, but the concern was new, having been only two years at work, and the public had still to be educated to it. They had now turned the corner, and begun to pay 5 per cent. to the ordinary shareholders, which was not a mean dividend, and he trusted that they would in the future never pay less. The chief alteration in the staff had been the appointment of Mr. Frank Bailey as engineer to the Company. Upon this appointment they could congratulate themselves, and they had already benefited therefrom The business of the Company had grown very rapidly. The number of consumers was 242 at the end of 1892, 1,080 at the end of 1893, and 2,740 at the end of last year. This increase would not go on for ever, but the progress shown was gratifying as proving that the citizens of London greatly appreciated the Company's efforts; £19,064 had been written off in order to pay for all the expenses connected with the issue of the various classes of shares and the debenture stock. The ordinary shareholders had sacrificed a good deal in having permitted the Board to issue preference shares and debenture stock at a higher rate of interest than possibly it was necessary to offer, but this had enabled them to be issued at a premium, by means of which a reserve fund had been formed. The combined reserve and depreciation fund was not idle money, but was invested in consols to the amount of £40,000 odd, and £15,200 was invested in Metropolitan 2½ per cent. consolidated stock. The present market value of these securities was £56,000, to which had to be added the balance of premiums on the last issue of debenture stock and other sums, making a total altogether of about £90,000 They had had trouble in connection with their condensing plant at Bankside, as the strainers choked very rapidly owing to the leaves and straw in the Thames. A new machine was being designed to clear the strainers. The public lighting of the City had been satisfactory, the gas-posts having been moved away shortly after their last meeting. There had been only six breakdowns, and the number of lamp-hours was over 2,000,000, and the percentage of extinction 0·067. In private lighting the percentage was 0·012. They had arranged a system of discounts so as to reach the small consumer. They were waiting for an order from the Corporation for lighting the lesser streets, and were urging them to come to some decision as to the system to be adopted for lighting the same. They had acquired at fair market value a big oil-stores next door to their works. This had been a danger to them, and they could put up offices and stores on the site. After alluding to the dinner which was given by the Company at the Cannon-street Hotel in order to demonstrate the advantages of electrical cooking, the Chairman said that the whole of their boilers, with one or two exceptions, were fitted with automatic stokers, which was an economy, and the smoke nuisance had been abated. They now had 157,000 to 160,000 lamps connected, and they had an ample reserve. They metered last year 2 602,217 units, compared with 1,741,099 units in 1893. The working expenses fell as the output became greater; but, on the other hand, as their machinery increased, the depreciation and reserve must increase. The statutory price was 8d. per unit, but the average price received by the Company was 7·7d., owing to discounts. There were now 144,086 lamps connected, and 7,157 to connect. Applications were coming in to the average number of about 1,000 per week. The staff had done their best in every way.

Mr. Joseph Braithwaite, jun., seconded the motion, and made a speech, but as the chairman had pretty thoroughly covered all the ground, his observations were mainly a repetition of those of Sir David Salomons.

Some questions were asked, among those speaking being **Mr. Sydney Morse**, who suggested that the Company should proceed against the gas company for damages in connection with the Southwark Bridge explosion.

In reply to the questions, the **Chairman** said that the Company knew nothing more about the telephone tube matter than was to be read in the reports of the meetings of the Commissioners of Sewers. As regarded explosions, the question was under the consideration of the Board of Trade. They were doing their best to avoid accidents, and did not propose to take action against the gas company, with which they were on good terms. The lesser streets in the City would be lighted as soon as they could get the Corporation to decide. The allowing of discounts would not have an injurious effect, but the contrary.

The motion having been adopted, the **Chairman** moved and **Mr. E. Lucas** seconded the payment of the dividends. The

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Chairman moved and **Mr. McCrory, Q.C.**, seconded the re-election of the retiring directors, Mr. Lucas and Colonel Martindale. The **Chairman** moved and **Mr. F. W. Reynolds** seconded the issue of the remaining £100,000 of debenture stock, and **Mr. H. P. Leach** moved and **Mr. S. Marriott** seconded the re-election of Messrs. Pannell and Co. as auditors. All these motions were passed unanimously.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

The thirty-first ordinary general meeting of this Company was held on Tuesday at the offices, 38, Old Broad-street, Admiral Sir George H. Richards, K.C.B., occupying the chair.

The **Chairman**, after referring to the death of one of the directors, Mr. Philip Rawson, said that the Board had lately elected Sir Robert Herbert and Admiral Sir Anthony Hoskins as directors. The Board could congratulate the shareholders on the results of the last year's work. They had carried out two rather large operations last year. They had laid a cable for the Eastern Extension Company by the China Seas, between Singapore and Labuan in Borneo, and Hong-Kong in China. This cable was something over 1,700 miles in length. Then they had laid a cable for the Anglo-American Company across the Atlantic between Ireland and Newfoundland. That cable was somewhere about 2,000 miles in length, and he believed it was a cable of the largest capacity that had ever been laid. Both these works were carried out with great success, and they were crowded into the half-year. Since then they had laid some smaller lengths of cable for various foreign Governments and companies. and on the whole they had been able to pay a dividend of £1. 8s. a share, including the interim dividend paid in July. The Company had no contracts in hand, and they were meeting this year with really less work in progress than they had had for some time before. It not unfrequently happened that most of the year's work came at the half-year, as it did last year. They, therefore, hoped to get better business, and, at all events, they might depend that all the exertions of the Company and the executive would be devoted to that end. Their particular work at present was manufacturing certain lengths of store cable to be ready for use, and they were taking advantage of the lull to put the machinery into such a state that it would enable them to do the work more economically and efficiently when there was a demand upon it.

Mr. Campbell seconded the adoption of the report, which was unanimously agreed to.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

An extraordinary general meeting of this Company was held yesterday afternoon at the Cannon-street Hotel to consider and, if approved, to confirm as special resolutions certain resolutions which were passed at the extraordinary general meeting held on 5th ult., and to which we referred at the time.

In the absence of Mr. J. S. Forbes, owing to influenza, the chair was taken by the Earl of Lichfield.

The **Chairman** said it was not necessary to say much on the subject, the object of the proceedings being to obtain a quotation on the Stock Exchange.

Major Flood-Page seconded the resolution, which was carried unanimously.

NOTTING HILL ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: William Crookes, Esq., F.R.S. (chairman); Arthur Ellis Franklin, Esq.; Alexander Howden, Esq.; James Thomas Jervis, Esq.; Francis Radford, Esq.; Sidney Waters, Esq. Engineer and manager, G. Schultz. Secretary, R G. Rawkins.

Report of the directors and abstract of accounts at December 31, 1894.

The expenditure on capital account at the date of the last balance-sheet amounted to £78,528. 19s. 10d. During the year a further sum of £5,032. 1s 7d. was expended, bringing up the total to £83,561. 1s. 5d. The principal item of expenditure is £4,083. 4s. 7d. for mains—the greater part of which represents the cost of the extension to Melbury-road and Addison-road. Against this capital expenditure £4,410 of preference shares were issued. The preliminary expenses, compensation, and cost of administration during construction, amounting to a sum of £5,205. 5s. 4d., have been transferred to a suspense account, with a view to their being gradually written off out of revenue by means of a sinking fund. The total expenditure charged to capital account now stands, therefore, at £78 335. 16s. 1d. The revenue account shows a profit of £2,401. 17s. 8d., as compared with profits of £1,481. 7s. 1d. in 1893, and £112. 6s. 1d. in 1892, and a loss of £554. 18s. 6d in 1891. The amount received from the sale of current shows an increase of £687. 4s., and the expenditure shows a decrease of £127. 2s. 8d The directors, who are entitled to fees amounting to £1,000, propose to draw for their services for the year 1894 the sum of £300. After payment of this sum the revenue account shows an available profit amounting to £2,101. 17s. 8d. Out of this the following sums have been set aside—(*a*) to depreciation, £600; (*b*) to 3 per cent. written off the preliminary expenses, £156. 3s. 2d., leaving a balance, after allowing for the other items on the net revenue account, of £1,243. 14s. 7d. available for dividends, which the directors propose to distribute as follows: (1) by the payment of a dividend at the rate of 6 per cent. per annum, less income tax, on the ordinary preference shares for the year ending December 31, 1894, £566. 6s. (an interim dividend on these shares was paid on July 31); (2) by the payment of a dividend at the rate of 2s. per share free of income tax on the ordinary shares, £645. 4s.; (3) carrying forward the balance of £32. 4s. 7d. The engineer reports that the machinery and plant at the central station, as well as the mains, are in good condition, and no accident of any kind has occurred. In view of recent occurrences in other districts, the directors are taking steps to ventilate the culverts in order to prevent any possible accumulation of gas. The number of houses on the circuit has increased from 173 to 234, and the number of lights from 12,153 to 15,669. The House-to-House Electric Light Supply Company, Limited, having decided to abandon their area in the northern part of Kensington, your directors, after prolonged negotiations with the local authority, decided to apply to Parliament for powers to extend over the whole of the northern portion of Kensington, thereby more than doubling the area served by them. An extraordinary general meeting was called in order to modify the articles of association so as to give the directors the necessary powers, and application has been made in the usual form through the Board of Trade to Parliament for an extension order for the district in question. The standing orders having been complied with, and no notice of opposition having been given, the directors anticipate that the necessary powers will be conferred upon them during the current session. If the extension powers are granted, the area of this Company will consist of almost the whole of that part of the parish of Kensington north of Kensington High-street. The directors desire to express their appreciation of the services of Mr. George Schultz, their engineer and manager, whose zeal and energy has largely contributed to the progress of the Company. The directors who retire are Messrs. A. E. Franklin and Francis Radford, and, being eligible, they offer themselves for re-election. The shareholders' auditors, Messrs. Fox, Sissons, and Co., retire, and, being eligible, they offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1894.

Dr.				£	s.	d.
A.—Generation of Electricity.						
Coal and other fuel, including dues, carriage, etc.	£459	12	4			
Oil, waste, water, and engine-room stores	112	9	6			
Wages and gratuities at generating station	354	1	0			
Repairs and maintenance as follows: (1) buildings, £16. 0s. 9d.; (2) engines, boilers, £107. 8s. 5d.; (3) dynamos, £29. 12s. 11d.; (4) other machinery, instruments, and tools, £49. 15s. 4d.; (5) accumulators, £197. 15s.	400	12	5			
				1,326	15	3
B.—Distribution of Electricity						
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same				111	14	2
C.—Rents, Rates, and Taxes.						
Rates and taxes				209	1	0
D.—Management Expenses.						
Salaries of engineer and manager, secretary, clerks, and messengers	553	2	0			
Stationery and printing	53	10	11			
General establishment charges	69	0	4			
Auditors of Company	31	10	0			
Auditor appointed by the Board of Trade under the provisions of the order	24	0	8			
				731	3	11
E.—Law and Parliamentary Charges.						
Law expenses				26	16	8
F.—Special Charges.						
Insurances	30	7	0			
Rent of wayleave	5	0	0			
				35	7	0
G.—Connecting installations, and sundry stores				280	11	0
Balance carried to net revenue account				2,401	17	8
				£5,123	6	8

Cr.	£	s.	d.
Sale of current per meter, less discounts, and after providing for bad debts	4,194	8	8
Rental of meters and other apparatus on consumers' premises	230	17	0
Connecting installations, sale of stores, etc.	385	9	0
Rents receivable	262	14	6
Transfer fees	6	3	6
The Electrical Association—balance received on the winding up of this association	43	14	0
	£5,123	6	8

Dr. GENERAL BALANCE-SHEET, DEC., 31, 1894.	£	s.	d.
Capital account—amount received	82,890	0	0
Sundry tradesmen and others, due on contracts for fuel, stores, etc., to December 31, 1894.	662	2	9
Sundry creditors	826	3	2
Depreciation fund account	600	0	0
Net revenue account—balance at credit thereof, £1,543. 14s. 7d.; less interim dividend paid on ordinary preference shares, £292. 6s. 9d.	1,281	7	10
	£86,259	13	9

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Cr.	£	s.	d.
Capital account—amount expended for works, including cost of provisional order	78,335	16	1
Sundry debtors for current supplied, etc., to December 31, 1894	1,838	14	3
Other debtors	30	6	5
Stores on hand at December 31, 1894—lamps, £29; meters and switches, £246. 0s. 2d.; coal, £23; general, £156. 12s. 4d.	454	12	6
Stock (movable plant and tools)	274	14	3
Cash at bankers—Parr's Banking Company and the Alliance Bank, Limited, Notting Hill, £259. 19s.; cash in hand, £16. 9s. 1d.	276	8	1
Preliminary expenses, compensation, etc., £5,205. 5s. 4d.; less 3 per cent. written off, £156. 3s. 2d.	5,049	2	2
	£86,259	13	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., DURING THE YEAR ENDING DEC. 31, 1894.

Quantity generated in B T. units	145,948
Quantity sold to private consumers by meter	130,266
Quantity used on works for lighting and testing	3,652
Total quantity accounted for	133,918
Quantity lost in distribution and not accounted for	12,030
Total maximum supply demanded (8-c.p. lamps)	15,669

In moving the adoption of the report on Tuesday, the **Chairman** (Mr. W. Crookes) said that the progress of the Company, though slow, was certainly sure. The issue of preference shares had increased by 441. Since the end of the year, however, a further 450 of these shares had been allotted, leaving the unissued share capital at the present time at £12,610. Borrowing powers which extended to £50,000 had not yet been exercised. The amount spent on capital account during the year amounted to £5,032. 1s. 7d., but, notwithstanding this fact, the total expenditure was £193. 3s. 9d. less than that which appeared in the previous year's account. The explanation was that the sum of £5,205. 5s. 4d. in former accounts, representing the cost of general administration and management expenses, etc., during construction and preliminary expenses to the first general allotment of shares, had been transferred, under the advice of the auditor of the Board of Trade, to a suspense account. There had been an increase in the revenue of £793. 7s. 11d, and the expenses for the same period had decreased by £127. 2s. 8d. The staff deserved thanks for the manner in which they had carried out their duties in order to bring about that result. The business was now being worked on more economical lines than any similar undertaking in London. The gross profit had risen from £1,481 to £2,401, showing an increase of nearly 70 per cent. This, of course, was brought about principally by the additional number of lamps connected; these had increased to the extent of 3,500 during the year, or more than 800 above the additions for the previous year, being, in fact, a larger increase than during any 12 months since the commencement. Nearly £1,300 had been taken out of the year's revenue for repairs and depreciation, or 25 per cent. of the gross receipts. The lamp earnings were still very low, reaching only to about 6s. for each 8-c.p. lamp, but considering the smallness of the Company's output, the sheer cost per unit reflected the greatest credit on the engineering staff. Towards the end of the year an important extension of the mains was made from the Phillimore district along Kensington-road, throughout Melbury-road, and a part of Addison-road. Powers had also been applied for to light an additional area. No accident of any kind had occurred, and although the winter had been exceptionally severe everything had progressed satisfactorily, with the exception of a little water recently getting into the culverts through the bursting of a water-pipe. No stoppage whatever had occurred in the supply of current throughout the year. With one exception of two hours, current had been supplied to their customers day and night uninterruptedly since it was first switched on in May, 1891. Now that the dividend earning point had been reached there was every reason to believe that it would go on increasing, and the future increased prosperity of the Company seemed to him fully assured.

Mr. A. Howden seconded the motion, which was adopted unanimously.

Mr. Burness moved, and **Mr. Battanshaw** seconded, the re-election of the retiring directors, which was agreed to.

On the motion of **Mr. Matterson**, seconded by **Mr. Bradford**, the auditors were reappointed.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

Directors: J. Irving Courtenay, chairman; Major-General Webber, C.B. (retired R E.), deputy-chairman; Nugent Daniell; Emile Garcke; George N. Marten. Managing engineer, Frank King. Secretary, S. J. Cluer.

Report of the directors (with abstract of accounts) to be presented to the ordinary general meeting of the Company, to be held at the Central Station, Draycott-place, S.W., on Tuesday, March 5, at 12 noon.

The 6,000 6 per cent. preference shares of £5 each issued in April last at a premium have been fully subscribed. The balance of premiums on the preference shares, after deducting the expenses of issue, amounts to £1,399. 18s. 7d. This sum has been applied to the reduction of the preliminary expenses account in the general balance-sheet, and a further sum of £834. 4s. 5d. has been taken from profits to extinguish this account. The revenue account shows a credit balance of £8,096. 6s. 9d., which, with the balance of £619. 4s. 3d., brought forward from last account, and £1,339. 18s. 7d., the balance of premiums above referred to, makes the total amount to the credit of net revenue account... £10,055 9 7

After deducting interest on debentures	£2,214	0	0		
Placing to renewal and depreciation fund	1,500	0	0		
Writing off preliminary expenses	2,174	3	0		
And providing for the sundry small items shown	175	15	2		
				6,063	18 2
There remains a balance of				£3,991	11 5

The directors recommend that this should be applied to a payment of dividends for the past year of 6 per cent. on the preference shares and of 5 per cent. on the ordinary shares, leaving a balance of £666. 9s. 4d. to be carried forward to next account. During the year, extensive alterations, embodying the latest improvements in the arrangements of the generating and distributing plant, have been made at the company's Cheyne-walk station, which was acquired in 1893. This station is now in full work, and has capacity for considerable increase of plant. The new sub-station in Pavilion-road is also in complete working order. The number of lamps added in 1894 is 6,621, bringing the total on December 31 to 47,286. The 6 per cent. first mortgage debentures amounting to £30,000, issued in the early days of the Company, are repayable on September 29, 1895. There are also second debentures amounting to £6,900 outstanding, which are terminable at six months' notice. To enable the directors to make provision for the redemption of these debentures, and to provide capital for necessary extensions, the resolution included in the accompanying notice will be proposed to the shareholders for their sanction at the general meeting on March 5, 1895. It is with great regret that the directors have to record the death of their esteemed colleague Sir George R. Prescott. Mr. George N. Marten, a director of the London and South-Western Bank, has been elected to fill the vacancy, subject to the confirmation of the shareholders. The retiring directors are Major-General C. E. Webber, C.B., and Mr. George N. Marten, who, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1894.

A.—To Generation of Electricity.

Dr.	£	s.	d.	£	s.	d.
Coal or other fuel, including expenses on the same	2,080	13	3			
Oil, water, cotton waste, and engine-room stores	352	15	3			
Wages of men	983	12	10			
Repairs, maintenance, and renewals as under—buildings, £82. 16s. 2d.; engines and boilers, £387. 14s. 1d.; dynamos, £24. 17s. 8d.; instruments, tools, and sundries, £70. 7s. 11d	565	15	10			
				3,982	17	2

B.—To Distribution of Electricity.

Wages at out-stations, meter winding and reading, etc.	339	3	0			
Stores used at out-stations, etc.	28	8	0			
Repairs, maintenance, and renewals, as under—mains, £14. 10s. 3d.; accumulators and apparatus at distributing station, and motor transformers, £132. 9s. 6d.; meters on consumers' premises, £30. 0s. 9d.	177	0	6			
				544	11	6

C.—To Rent, Rates, and Taxes.

Rents payable	618	7	6			
Rates and taxes	269	6	1			
				887	13	7

D.—To Management Expenses.

Directors' remuneration	600	0	0			
Salaries of staff	948	7	4			
Salary or commission of collector	87	0	1			
Stationery and printing	55	11	9			
General establishment charges	109	16	2			
Auditors of Company	25	0	0			
				1,825	15	4

E.—To Law and Parliamentary Expenses.

Law expenses	29	19	0			
				29	19	0

F.—To Special Charges.

Insurance	113	13	4			
Wayleaves	5	0	0			
				118	13	4
Balance carried to net revenue account				8,096	6	9
				£15 485	16	8

Cr.	£	s.	d.
Sale of current (less allowances made)	14,788	3	7
Rental of meters	533	16	11
Transfer fees	1	10	0
Rents receivable and sundry small accounts	162	6	2
	£15,485	16	8

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NET REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1894.

Dr.	£	s.	d.
Interest on debentures paid and accrued to date...	2,214	0	0
Fees to trustees for debenture-holders	100	0	0
Interest on mortgage of freehold (purchased subject to mortgage) and on loans	61	7	10
Renewals and depreciation fund account	1,500	0	0
Amount written off preliminary expenses in suspense	2,174	3	0
Bad debts written off	14	7	4
Balance available for dividend on the preference and ordinary shares	3,991	11	5
	£10,055	9	7

Cr.	£	s.	d.
Balance from last account, £3,105. 2s. 7d.; less dividend of 5 per cent. paid on the ordinary shares, £2,485. 18s. 4d.	619	4	3
Balance from revenue account (being gross profit on working).....	8,096	6	9
Balance of premiums on preference shares after deducting expenses of issue (written off preliminary expenses, included in £2,174. 3s. *per contra*)	1,339	18	7
	£10,055	9	7

GENERAL BALANCE-SHEET, DEC. 31, 1894.

Dr.	£	s.	d.
Capital account—amount received	117,810	0	0
Bills payable	2,022	1	4
Sundry creditors	3,005	5	7
Net revenue account—balance at credit thereof ...	3,991	11	5
	£126,828	18	4

Dr.	£	s.	d.
Capital account—amount expended, £119,705. 5s. 2d.; less renewals and depreciation fund account, £2,500	117,205	5	2
Stores on hand—coal, £54. 6s. 6d.; general stores, including work in progress, £1,129. 17s. 11d. ...	1,184	4	5
Preliminary expenses in suspense, £2,174 3s.; less amount written off, £2,174. 3s.	—		
Sundry debtors for current supplied, etc., less bad debts deducted	6,025	14	3
Cash at the London and South-Western Bank, £2,389. 5s. 3d.; cash in hand, £24. 9s. 3d.....	2,413	14	6
	£126,828	18	4

BIRMINGHAM ELECTRIC SUPPLY COMPANY, LIMITED.

The following is the report of the directors to be submitted at the ordinary general meeting of the Company at the offices, Dale End, on the 7th inst.

Your directors have pleasure in presenting their fifth annual report and balance-sheet. The amount of net profit, including the balance of £409. 12s. brought forward from last year, is £5,609. 5s. 6d. Out of this your directors recommend the payment of a dividend of 4 per cent., absorbing £2,754. 18s. 6d., placing £1,602. 15s. 3d. to the credit of the depreciation reserve fund, and a further sum of £250 to the general reserve fund, carrying forward the balance of £1,001. 11s. 9d. to next year's account. On making the above appropriation, the total of depreciation, general reserve, and of undivided profits will amount to £6,864. 0s. 8d. There has been a steady increase in the Company's business during the past year. The total number of 16-c.p. lamps or their equivalent on order, at December 31, 1893, was 10,223, and on the same date in 1894 the number was 12,138. The additions since the close of the financial year have brought the number up to 12,551. Several motors have for some time past been working from the Company's system, and, with the reduced scale of charges for current used for this purpose, their general adoption is only a question of time as their convenience and economy become known. During the past year Parliament has confirmed the provisional order extending the Company's operations over Edgbaston and the jewellers' quarter. These areas should ultimately form valuable additions to the Company's business. The capital expenditure during the year amounts to £12,674. 1s. 1d., and includes a portion of the expenditure on account of buildings to complete the works at Dale End, the addition of new plant, and the extensions of mains and services. Your directors have acquired certain freehold and leasehold properties in Newhall-street and Monument-lane for works in connection with the new parliamentary areas, the cost of which forms part of the capital expenditure of the year; and, as they have made arrangements to at once carry out such portions of the works as may be necessary to supply these areas, it is proposed to shortly call up the balance of unpaid original capital. To further provide for the additions to the Company's business, the following resolution will be submitted to the shareholders—viz., "That the capital of the Company be increased by £100,0000, divided into 20,000 shares of £5 each (making the total nominal capital £200,000), to be issued at such times and on such terms as the directors may from time to time think fit." It is thought desirable that a quotation on the Birmingham Stock Exchange be obtained for the Company's shares, and with this object a resolution will be proposed authorising the directors to relieve members of the Birmingham Stock Exchange from the operation of Articles Nos. 24 and 25. In accordance with the articles of association, two directors, Mr. George S. Albright and Mr. G. H. Johnstone, retire by rotation, and are eligible for re-election. The auditors, Messrs. Sharp, Parsons, and Co., also retire and are eligible for re-election.

BALANCE-SHEET, DEC. 31, 1894.

Dr. Capital and Liabilities.			£	s.	d.
Capital registered—viz., 20,000 shares of £5 each			100,000	0	0
Capital issued.....			100,000	0	0
Capital called up—viz., 10,000 shares, £5 per share			50,000	0	0
10,000 shares, £3 per share.....			30,000	0	0
			80,000	0	0
Sundry creditors			3,449	4	5
Depreciation reserve fund, as at December 31, 1893.....	£3,509	13 8			
Add additions to date	1,602	15 3			
			5,112	8	11
General reserve			500	0	0
Profit and loss account—balance from December 31, 1893	£409	12 0			
Profit one year to date.....	5,199	13 6			
	5,609	5 6			
Deduct amount applied to depreciation reserve	1,602	15 3			
			4,006	10	3
			£93,068	3	7

Cr. Property and Assets.			£	s.	d.
Land and buildings as at December 31, 1893.....	£14,483	14 8			
Add further outlay on land and buildings to date	9,469	18 7			
			23,953	13	3
Mains, machinery, and plant, furniture and fittings, meters and electrical instruments, as at December 31, 1893	54,445	2 9			
Add further outlay to date	3,204	2 6			
			57,649	5	3
			81,602	18	6
Cost of provisional orders to December 31, 1893.....	3,737	4 9			
Add further expenses on account of additional areas	237	9 11			
			3,974	14	8
Preliminary expenses			1,685	2	4
Cash in hand and with bankers..... ...			1,217	9	4
Sundry debtors			3,700	12	8
Stock of stores and work in progress at per signed stock book			887	6	1
			£93,068	3	7

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Brentford.—The Urban District Council require tenders by the 12th inst. for the supply and fixing of telephones and electric calls in connection with the fire brigade. Further particulars will be found in our advertisement columns.

Llanelly.—The Borough District Council desire plans, designs, specifications, and estimates of cost for the supply and installation of electrical plant and machinery, including street lamps and laying down mains. Plans of the district can be obtained from Mr. George Watkeys, C.E, borough surveyor, Llanelly. The plans, etc., are to be sent to the clerk of the Council before the 25th inst. Details are given in our advertisement columns.

RESULTS OF TENDERS.

Norwich.—The Town Council have accepted the tender of Messrs. Laurence, Scott, and Co., at £458, for providing and fixing fittings for lighting St. Andrew's Hall by electricity.

Kingston-on-Thames.—The Town Council have accepted the tender of Messrs. Harrison, Cole, and Co. for establishing telephonic communication between the electric light station and the engineer's house.

BUSINESS NOTES.

Hove.—The Works Committee of the Urban Council do not at present favour street-lighting by electricity.

Eccles.—The Town Council have decided to carry out an electric lighting scheme at an expenditure of £20,000.

Blackpool.—The Corlett Engineering Company have received an order from the Corporation to supply two dynamos.

Alverthorpe (Wakefield).—It is the intention of the Parish Council of this village to light it either by gas or electricity.

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Bradford.—The Gas and Electric Lighting Committee have under consideration a proposal to extend the electricity works.

Shrewsbury.—The work of laying the mains has been commenced by the Shropshire Electric Light and Power Company.

Pupil Required.—The engineer (Mr. J. E Stewart) to the Derby Corporation electric light station has a vacancy for an articled pupil.

Liverpool.—It is possible that the Corporation will call in the services of a consulting engineer to advise them on electric lighting matters.

United Ivy Mines.—A cablegram states that the new mill is in perfect order, but that Moodie's electric power plant is not yet quite completed.

Mersey Railway.—The Company are promoting a Bill to empower them to work their railway by electric or other motive power, and to raise additional capital.

Radcliffe.—A member of the District Council believes that there is sufficient water at the New-road Mill to produce electrical energy for the lighting of the district.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 24th ult. amounted to £847, as compared with £616 in the corresponding week of last year.

Office Alterations.—The Establishment Committee of the London County Council have authorised an expenditure of £20 for alterations to the electric light fittings at the central offices.

Aroscopic Lens Company, Limited.—This Company has been registered with a capital of £1,000 in £1 shares, to carry on business as manufacturers of and dealers in electrical, medical, and optical instruments.

Bournemouth—The Town Council have resolved to write to the electric supply company asking them to supply to the Council electrical energy for all purposes on the same terms as they supply to the winter garden.

Atcham.—The Board of Guardians have instructed the clerk to communicate with the telephone company and ascertain the cost of connecting the telephone with the workhouse and the medical officer at Shrewsbury.

City of London Electric Lighting Company.—Mr. J. Cecil Bull, the manager and secretary, informs us that the warrants for the dividends on the preference and ordinary shares of the Company have been posted.

Universal Governments' Army, Navy, and Commercial Manufacturing Company, Limited.—This Company has been registered, with a capital of £937. 10s., to erect rolling-mills, etc., and to manufacture machinery, dynamos, etc.

W. J. Robinson and Co., Limited.—This Company has been registered, with a capital of £40,000 in £5 shares, to acquire the business of electrical engineers now carried on, under the style of Messrs. A. J. Robinson and Co., at Liverpool.

Bellingwe Development Syndicate, Limited.—This Company has been registered, with a capital of £30 000 in £1 shares. to acquire lands, mines, etc., in South Africa or elsewhere, and to carry on business as electrical and general engineers.

New Electrical Firm.—Messrs. Wood and Co , of 74, Cheapside, London, E.C , have established a branch as electrical engineers for the carrying out of complete electric light and power installations. Mr. L. A. S. Wood is the consulting electrician.

John Crossley and Co., Limited.—This Company has been registered, with a capital of £5,000 in £5 shares, to acquire the business of engineers, ironfounders, etc . now carried on at Bank Bottom Mills, Halifax, Yorks., by Messrs. John Crossley and Co.

Tramcar Lighting.—The North Staffordshire Tramways Company propose to make their cars additionally attractive by lighting them by electricity. A similar decision has been arrived at in the case of the London, Deptford, and Greenwich Tramways Company.

Blackburn.—The Blackburn Corporation have decided to light the Town Hall by electricity, and have instructed Mr. E. M. Lacey, A.M I C.E., of 19, Old Queen street, Westminster, S.W., to prepare plans and specifications for the carrying out of the work.

Wandsworth, S W.—The District Board of Works have resolved to ask the Board of Trade to reconsider their decision sanctioning the use of transformer-chambers in the public streets by the electric lighting company proposing to supply the district with electricity.

Battery and Motor Company, Limited.—This Company has been registered, with a capital of £12,000 in £5 shares, to adopt an agreement made between H. T. Barnet and F. J. Moffatt for the purchase of certain patents relating to improvements in primary batteries and motors.

Newington, S.E.—The General Purposes and Lighting Committee of the Vestry have appointed Mr. A. E. Smithers and Mr. J. A. Dawes delegates to join the deputation to the Treasury for the purpose of getting the period for granting electric lighting loans extended from 20 to 42 years.

Bailey's No. 2 South Gold Mining Company, Limited.—This Company has been registered, with a capital of £100,000 in £1 shares, to acquire any gold mines, mining rights, and auriferous land in Western Australia or elsewhere, and to construct and maintain rail and tramways, telegraphs, telephones, etc.

New Showrooms.—Messrs. Wm. Whitehouse and Co., of Empire Works, Brueton-street, Birmingham, makers of gas and electric light fittings, have opened permanent showrooms at 59, Holborn-viaduct, London, E C., where they have on view samples of their newest designs in gas and electric light fittings, etc.

Swindon.—The Water Board desire to have erected a telephone between the Board's offices in Old Swindon and the Public Offices at New Swindon. The clerk has been instructed to obtain the cost of having a private wire connected with the exchange.

City and South London Railway.—The receipts of the Company for the week ended February 24 were £949, against £945 for the corresponding week of 1894, or an increase of £4 The total receipts for the current period of the present half-year are £7,988, against £7,610 in the corresponding period of 1894, an increase of £378.

Tamworth Gold Mining Company, Limited.—This Company has been registered, with a capital of £85,000 in £1 shares, for the acquisition of any gold mines, mining rights, grants, concessions, and auriferous land in New South Wales and elsewhere, and to construct and maintain tram and rail ways, telegraph and telephones, etc.

Electric Power in Engineering Works.—Messrs. Greenwood and Batley, Limited, of Albion Works, Leeds, announce for the benefit of those who are watching the developments of electric transmission of power in engineering works, that they have secured from a foreign Government a large order for machine tools with electric motors combined.

Business Announcement.—The Unbreakable Pulley and Mill Gearing Company, Limited, of Hyde-road Engineering Works, West Gorton, Manchester, inform us that they have appointed Mr. John Chorley, Buttermarket-street, Warrington, as their agent for the sale of their "unbreakable" wrought-iron pulleys, mill gearing, special steel shafting, "Gorton" gas-engines, etc.

Empire Economic Steam Producer, Limited.—This Company has been registered, with a capital of £80 000 in £1 shares, to adopt an agreement, made between R. Klostermann and O. Friederici and C. W. Williams, for the acquisition of certain letters patent relating to improvements in grates used in boiler furnaces, and to carry on business as ironfounders and mechanical engineers.

Halifax and Bermudas Cable Company.—An official notice has been given in the Private Bill Office of the House of Lords that the Halifax and Bermudas Cable Company, Limited, does not intend to proceed any further with its deposited Bill for this session. Under this Bill it was proposed to make further provision with reference to the investment of the subsidy payable to the Company by her Majesty's Government.

Kingswood (Bristol).—A letter has been read at a meeting of the Kingswood District Council from the Bristol electrical committee, stating that the surveyor to the Kingswood Council might visit the Bristol central station with a view to obtaining any information he could as to the manner in which testing lights can be carried out. It was decided that the chairman, the surveyor, and Mr. A. Evans should visit the works in Bristol.

Cardiff—The Joint Standing Committee of the Glamorgan County Council had brought under their notice on Monday by Councillor Jotham the question of introducing the electric light into the County Offices. Mr. O. H. Jones said that the electric light in Cardiff was in a state of confusion. He thought that until they had the electric light in working order the county had better leave it alone. Alderman Rhys moved that the matter be postponed for six months, the motion being agreed to.

Kingston-on-Thames.—It appeared from the minutes of the Lighting and Market Committee, presented to the Town Council last week, that Major General Crozier had been appointed by the Local Government Board to hold an enquiry at the Town Hall last Monday in reference to the application by the Corporation for sanction to borrow an additional £10,000 for electric lighting purposes. The Town Council have decided to allow discounts ranging from 2½ to 10 per cent. It is probable that the post office will be lighted by electricity. The enquiry was duly held.

Bath.—The minutes of the Electric Lighting Committee presented to the Town Council last week contained a reference to the fact that the authority had decided to oppose the application of the electric light company for a provisional order by applying for one itself. The Mayor said he had asked the clerk what had been done, and he was told that at present nothing further could be done. Alderman Sturges said the Board of Trade had had informal notice of the intentions of the authority. Mr. Radway hoped the clerk would not allow the matter to slide too long, and it was decided that an early meeting of the Electric Light Committee should be called.

Killarney.—A report was presented last week to the governors of the district lunatic asylum stating, in regard to the lighting of the asylum, that the Killarney Electric Light Company had written a letter to the effect that they are prepared to lay the connecting mains from the distributing station in the town, including the construction of a transformer-house at the asylum end to the specification, and under the supervision of the consulting electrical engineer acting on behalf of the directors. The governors decided to approve of the installation of the electric light in lieu of gas, and requested Mr. Leake to prepare plans and specifications to enable them to advertise for tenders.

Southampton.—Attention was drawn at a meeting of the Harbour Board last week to the delay in completing the electric lighting contract at the Town Quay, the time for which was stated by the electrical engineer (Mr. J. G. W. Aldridge) to have expired. The clerk had been instructed to write to Messrs. Crompton and Co. calling their attention to the matter. Messrs. Crompton and Co. wrote, in reply, expressing regret that the Works Committee should feel dissatisfied that their contract was not quite completed. They urged that they had had some difficulties which

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were quite unexpected, and that no effort would be spared to get the work completed and out of hand.

Brighton.—The minutes of the Lighting Committee presented to the Town Council last week reported with reference to negotiations with the owners and lessees of 39, North-road, with a view to the purchase of those premises for the extension of the electricity generating station. It was resolved to accept the offer made and to apply to the Local Government Board for sanction to borrow £750 for 40 years to defray the cost. The manager was instructed to purchase at the sale of the plant belonging to the Brighton and Hove Electric Light Company, Limited, such articles as he deemed necessary for the Corporation electricity installation at an expenditure not exceeding £500. The Town Council confirmed the minutes.

Yeadon.—A special meeting of the Yeadon District Council has been held for the purpose of discussing the electric light question. Mr. James Flaxington, after a lengthy speech on the advantages of electric lighting, proposed that the Council call in an expert electrician to examine and report upon the tenders which had been sent in to the Council for the lighting of Yeadon by electricity. Mr. Herbert Marshall seconded the proposition. Mr. John Cooper opposed the motion, on the ground that electric lighting for Yeadon would not be a profitable undertaking, and moved, as an amendment, that the Council abandon the project altogether. The amendment was not seconded, and Mr. Flaxington's motion was carried.

St. Luke's, E.C.—The St. Luke's Vestry have been in correspondence with the Board of Trade on the subject of transformer-chambers under the footpath. It appears that the late surveyor of the parish pointed out that the gas-mains in the City-road were defective and that gas was continually escaping, and that at any moment a serious explosion might occur. Major Cardew, who had inspected the works with the engineer of the electric light company, stated that the company were willing to put clean shingle in the boxes in order to prevent an accumulation of gas. The Vestry agreed that this should be done in cases where it was possible, but decided to insist upon proper ventilation of the larger street boxes used as converting stations.

Appointments Vacant.—The Corporation of Cardiff are about to appoint a practical man to take charge of their electric lighting station at Canton, under the general supervision of the borough engineer, and invite applications for the post. Applicants must be experienced in electrical work and engine fitting, and have had actual experience in the charge of a high-pressure alternating system at an electric lighting station. The salary offered is £200 per annum Further particulars of the duties may be obtained on application to Mr. W. Harpur, borough engineer, Town Hall, Cardiff. Applications are to be delivered at the office of Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, by 7th inst. The Corporation of Walsall invite applications for the position of electrical engineer at the electric lighting station. The salary offered is £150 per annum. Applications are to be sent to Mr. John R. Cooper, town clerk, before the 16th inst. Further information is contained in our advertisement columns.

Birmingham.—The Technical School Committee of the Town Council will present a further report to the Council on Tuesday, furnishing additional particulars respecting the proposed expenditure of £14 000 upon the educational and other fittings in the new school, and £6,271. 8s. for lighting the school by electricity. At the last meeting of the Council the committee's recommendation as to lighting by electricity was criticised, and it was pointed out that the gas department tendered to light the school with ordinary flat-flame burners for £892. 17s , and with incandescent gas burners for £1,382 17s. The further discussion of the report was adjourned, it being understood that the committee in the meantime would provide the Council with other details as to their proposed expenditure. These details are contained in the report now issued. Six firms tendered for the equipment of the 116 rooms of which the new school will consist, the tenders varying from £20,510 to £13,226. It was resolved that the latter, that of Messrs. Parker, Limited, should be accepted. A revised specification was, however, issued. To the revised specification 29 tenders were received, and, subject to the approval of the Council, the committee purpose accepting the tender of Messrs. D. and G. Graham, of Glasgow, at the sum of £5,515. 14s. 2d. For the ornamental and other fittings, which were not included in the revised specification, it is estimated that a sum of £565 will be required, which sum, added to the amount of Messrs. Graham's tender, will make a total expenditure on this head of £6,080. 14s. 2d.

Leeds Tramways.—A deputation from the Leeds City Corporation had an interview with Mr. Bryce, President of the Board of Trade, at the House of Commons last week, to solicit his assistance in facilitating by the suspension of the standing orders the passage through Parliament of the Bill promoted in the House of Lords by the Corporation for the extension of the city tramways, and making provision for electric or other traction. The proceedings took the form not so much of set speeches as of general discussion, in which the arguments on behalf of the corporations were stated, and the matter thoroughly gone into. It was pointed out that only two corporations possess working powers such as the Leeds Corporation desire to obtain—namely, the Glasgow Corporation and the Huddersfield Corporation. Not caring to work under a license which might be withdrawn at any time, as in the case of Huddersfield, the Leeds Corporation desire to possess statutory powers to work the tramways without being called upon to let them except by a resolution of the Corporation itself. The President of the Board of Trade, as the London County Council have a similar Bill before the House of Lords, suggested that the Leeds Corporation should wait until they saw what was done with that Bill at the committee stage. At the close of the discussion, Lord Playfair suggested that the chairmen of committees for the House of Lords and House of Commons should confer together on the matter, feeling qnite sure that if they could only agree to a suspension of standing orders, this advice would have great weight with both Houses of Parliament.

Bankruptcy Proceedings.—An application was made last week at the London Bankruptcy Court to Mr. Registrar Hope for an order of discharge on behalf of William David Gooch, electrical engineer, formerly of Victoria-mansions, Westminster. The bankrupt attributed his failure chiefly to loss on contracts for lighting by electricity various exhibitions. He also had a contract for three years at Manchester for electric lighting. In connection with that contract he made a loss of £300 a year, and only got out of it by giving up the machinery. Mr. H. Brougham. the official receiver, reported that the accounts showed ranking liabilities £4,365, and no available assets. Proof to the amount of £2,147 had been lodged with the trustee. The bankrupt carried on business on his own account from 1885 to 1888, during which time he incurred the bulk of the indebtedness in connection with speculative electrical contracts, etc. Mr. B. Dennies appeared for the bankrupt in support of the application, and offered to have judgment for £150 entered against the bankrupt as a condition attaching to the discharge. After hearing the case, the learned Registrar said such an offer could not be entertained, as it was simply sanctioning a scheme for the payment of less than 7s. 6d. in the pound. He regarded the offence of insufficient assets in a rather serious light, seeing that the debts amounted to £4 300 and there were no assets. It had been urged that £1,000 of those liabilities were put upon the bankrupt in connection with the Oldham exhibition under circumstances of a misleading nature to the bankrupt. Allowing for the deduction of that sum, there was still a deficiency of over £3,000. It was clear that the bankrupt had undertaken electric lighting contracts without having sufficient funds at his command to carry them through with success. Having regard to all the circumstances of the case, the order of discharge would have to be suspended for three years.

Private Installations.—The contract for lighting the new Isle of Wight County Asylum has been obtained by Mr. F. Shalders, of High-street, Southampton The plant will consist of engine and dynamo for the heavy load, engine and dynamo for charging battery and for use as reserve, switchboards, steam-pipes, and wiring for about 800 lamps. Mr. Shalders is now putting down an installation at Fen Place, the residence of Mr. J. Stewart Oxley. The plant comprises engine and dynamo, accumulators, motors for pumping, churning, and cream separating, switchboards, and wiring for about 200 lamps. He is also wiring throughout the new County Offices, Winchester, for about 120 lamps. A complete organ-blowing plant for the Church of St. Lawrence, Southampton, has been installed by Mr. Shalders. The power for driving the motor is obtained from the local supply company's mains. The supply and regulation of wind are perfect in every respect, and give extreme satisfaction. This plant was designed and laid down by one of his assistants, Mr. T. Davis, who also superintended the installations previously mentioned. Messrs. Bennett and Druce, of Preston, have just completed an electric light plant for the St. Joseph's Church and Canon Walmsley's house, Preston. The installation consists of nearly 150 lights, complete with Crossley gas-engine, shunt-wound dynamo, and accumulators. In this installation the light is taken from the accumulators solely, the engine and dynamo being used simply for charging the latter. The firm have also received instructions to proceed with the electric lighting of the three-storeyed sheds at the Manchester Ship Canal Company's Salford Docks, where about 500 lamps of 32 c.p. and 50 c.p will be required. The lighting of the new Farmer's Arms Hotel, Preston, has also been entrusted to this firm. About 150 lamps will be installed, the current being taken from the Supply Company's mains.

Acton, W.—The District Council last week again discussed the question of the application of the London United Tramways Company for the Council's sanction to their project to carry their tramway to Acton-hill. Messrs. Walter Webb, the solicitor to the company, Mr. White, the chairman of the directors, and Mr. Kincaid, the engineer, have had several interviews with the Council on the subject. At present the company are empowered to double their line from the Shepherd's Bush boundary to Birkbeck-grove, at Acton, and to relay the whole of the present line with granite setts. What they desired to do, in addition, was to double the line from Birkbeck-grove to Birkbeck-road, with interlacing under the railway arch, and to carry a single line from Birkbeck-road to the top of Acton-hill. The offers made by the company were not considered by the Council to be sufficient, and the tramway people were reminded that the Council and the County Council had spent £20,000 in the widening of the High-street, which had made the proposed extension possible. After consideration the Council asked the company to pave the whole of the present and proposed track with hard wood, and to make a money grant of £1,000 to the Council in exchange for the concession of the sanction of the Council to the extension. Having deliberated with his colleagues, Mr. White said the company would make the money grant, but were not prepared to adopt wood paving throughout their line until they were permitted to use electric instead of horse traction. These terms the Council declined to accept, and it was suggested that the company should consent to repave the whole of their track

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with wood whenever the Council undertook the wood-paving of the rest of the road. This suggestion was not accepted, and ultimately the promoters of the undertaking were asked to decide between the extension, plus the wood-paving of the whole track, or no extension. Mr. White then intimated that if these were the minimum terms of the Council the company must abandon the extension project for the present. As neither side had further propositions to submit, the matter ended. The Council definitely decided not to consent to the extension.

PROVISIONAL PATENTS, 1895.

FEBRUARY 18.

3458. **Improvements in and connected with arc lamps.** John Brunswick Barton, 18, Southampton-buildings, Chancery-lane, London. (William Jandus, United States.)

3511. **An improved method of electrically signalling upon railways.** John Wesley Courtis, Frederick Parker Sibley, and Charles Dallimore, 22, Southampton-buildings, Chancery-lane, London.

3512. **An apparatus for electrically communicating from a fire-engine to a fireman in charge of hose on building.** John Wesley Courtis, Frederick Parker Sibley, and Charles Dallimore, 22, Southampton-buildings, Chancery-lane, London..

FEBRUARY 19.

3548. **Improved electric switch.** William Edge, 25, Tabard-street, Borough, London.

3573. **Improvements in telephonic apparatus.** Norval Landon Burchell, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3582. **Improvements in casings for electricity conductors.** Henry Reason, 111, Gloster-road, Brighton.

3593. **Improved wire draw vice and key, particularly intended for use in telegraph and telephone wire line work.** William Broomhead Shaw, 22, Glasshouse-street, Regent-street, London.

3622. **Improvements in electric dental engines.** William Eugene Wheeler, 53, Chancery-lane, London.

3625. **An improved process for coating or plating metals with aluminium or aluminium alloys by electrolysis.** Carl Oppermann and Ernest Bailey, 2, Wynyatt-street, London.

FEBRUARY 20.

22965A. **Improvements in the method of and apparatus for electrically heating metal or other conducting bodies.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Lewis Coffin, United States.) (Date claimed under Patents Rule 19, November 27, 1894.) (Complete specification.)

3633. **Improvements in or connected with the distribution of electricity.** Thomas Parker, John Harold Woodward, and Edmund Scott Gustave Rees, Wolverhampton.

3662. **Improvements in electrical contacts for torpedoes.** Joseph Rogerson Scott, Akenside-hill, Newcastle-on-Tyne.

3679. **Improvements in the construction of electric arc lamps.** Thomas Sedgwick Foster, 18, Buckingham-street, Strand, London.

3685. **Improvements in the insulation of electric conductors.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

3687. **Improvements in or relating to electric traction.** Wilfrid Swanwick Boult and Cedric Randal Boult, 323, High Holborn, London.

3693. **New and improved electric lock and system of electric locking for the purpose of securing additional safety in railway signalling.** James Frederick Walter Morris and George Mumford, 20, Grummant-road, Peckham, London.

3701. **Improvements in electrical driving gear for vehicles.** Walter Charles Bersey, 53, Chancery-lane, London.

FEBRUARY 21.

3770. **Improvements in or connected with the filaments of incandescent electric lamps.** Jesse Graham and Harry Chapman, 33, Chancery-lane, London.

3779. **Improvements in economising apparatus for the carbons of electric arc lamps.** Alfred Albrecht, 40, Chancery-lane, London. (Complete specification.)

3788. **Improvements in electric locomotives chiefly designed for use in mines.** Bruno Lebrun, 45, Southampton-buildings, Chancery-lane, London.

FEBRUARY 22.

3809. **Improvements in electric and galvanic batteries and accumulators.** Joseph Baxeres Torres, 13, Golden-square, London.

3812. **Improvements in electrical switches or circuit closers.** Meyer H. Goldstone and James H. Ward, Gorton Brook Electric Works, Manchester.

3821. **A new form of alternating-current dynamo-electric generator.** James Finlayson, 114, West Nile-street, Glasgow.

3841. **Improvements in the method of and apparatus for ventilating manholes, electric light boxes, and underground chambers or cellars of all sorts.** George Hinde Nisbett, 6, Lord-street, Liverpool.

3864. **Improvements in power gearing and current-controlling apparatus for electric cars.** Elmer Ambrose Sperry, 40, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 24, 1894, being date of application in United States.) (Complete specification.)

3866. **Improvements in electrical switches.** Reginald Wilmot Hayes Newington and Richard Hewlett, 1, Queen Victoria-street, London.

3874. **Improvements in adjustable electric lights.** Alexander Leslie Fyfe, 22, Southampton-buildings, Chancery-lane, London.

FEBRUARY 23.

3903. **An improvement in electrical conductors.** Hugh Donald Fitzpatrick, 70, Wellington-street, Glasgow. (The Electric Bell and Resistance Company, United States.) (Complete specification.)

3954. **Improvements in and relating to telephone systems.** Salomon Berditschewsky (called Apostoloff), and Moïse Freudenberg, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1890.

9361. **Electric reduction of metals.** Willson. (Third edition.)

1892.

21696. **Electric smelting of ores, etc.** Willson. (Second edition.)

1894.

1903. **Secondary battery electrodes.** Wuillot.

2493. **Electric lampholders.** Randell.

2730. **Protector for electric cables.** Grant.

25076. **Telegraphic transmitters.** Boult. (Spiro.)

1895.

56. **Electrical cut-out.** Siemens Bros. and Co. (Siemens and Halske.)

157. **Telephone call stations.** Jensen. (Jacobsen.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	£5	5½-5⅝
Bournemouth Electric Company	—	—
Brush Company, Ordinary	£2	2⅜-2½
—— Nom. Cum., 6 per cent. Pref.	£2	2⅜-2⅝
—— 4½ Debenture Stock	100	115-118
Charing Cross and Strand	£5	5-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13½-14½
—— 6 per cent. Cumulative Pref.	10	15½-15⅝
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	46-48
—— 4 per cent. Debenture Stock	100	130-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	£5	3-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	102 107
Electric Construction, Limited	£2	½-½
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	£2	1½-1⅝
Electricity Supply Company for Spain	£5	—
Elmore's Copper Depositing	£2	1½-1⅝
Elmore's French Company	£2	—
Elmore's Wire Company	£2	1½-1⅝
Fowler-Waring Cables	£5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	10-11
—— Preference	—	12
House-to-House Company, Ordinary	£5	2½-2⅝
—— 7 per cent. Preference	£5	6½-7
India Rubber and Gutta Percha Works	10	23½-24½
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge	£5	7-7½
—— 6 per cent. Pref.	£5	7-7½
Liverpool Electric Supply, Ordinary	£5	7½-7⅝
—— Pref.	—	—
Liverpool Overhead Railway	10	8 9/16-8 11/16
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	£5	½-½
Metropolitan Electric Supply	10	9½-10½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	£5	5½-5⅝
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	£5	6-6½
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7-7½
Oriental and Electric Company, £1 shares	£1	1-1½
—— £5 Shares	£5	7-7½
—— £4½ shares	£4½	5½-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	£5	7½-8
—— 7 per cent. Pref.	£5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	£12	45-47
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	£5	7½-8
Yorkshire House-to-House	£5	4½-4⅝

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NOTES.

Private Bills.—The Leeds Corporation Tramways Bill was read a second time in the House of Lords on Monday.

Chemical Society.—The anniversary dinner of this society will take place at the Hotel Metropôle on Wednesday, the 27th inst.

Battersea Polytechnic.—The annual distribution of prizes and certificates in connection with this institution took place on Wednesday night.

Institution of Electrical Engineers.—Mr. N. S. Keith, member, will read a paper on "The Electrolysis of Gold" before this Institution on Thursday next, the 14th inst.

Institution of Mechanical Engineers.—The summer meeting of this institution will be held in Glasgow. The meeting will commence on Tuesday, July 30, and will last four days.

Thames Valley.—A committee of the Conservators of the River Thames have resolved to consider a suggestion that the locks in the Thames valley should be connected either by telegraph or telephone.

Telegraphy between Burma and Siam.—The Indian Government have sanctioned a survey for a telegraph line from Mone in the Shan States to the buffer State on the Siam frontier.

University Examiners.—The Senate of the University of London, on April 24, will elect examiners in various departments, including two in mathematics and natural philosophy and two in chemistry.

Electro-Culture.—The members of the Wolverhampton Gardeners' Mutual Improvement Society met on Wednesday at the Midland Café, Queen's-square, when a lecture was delivered by Mr. G. W. Fairall upon "Electro-Culture."

Smoking Concert.—The third annual smoking concert of the employés of Messrs. Drake and Gorham was held at Cloot's Restaurant, Victoria-street, S.W., on Wednesday evening. A very pleasant programme was provided.

Transmission of Power.—The Italian Minister of Agriculture and Commerce has appointed a commission to investigate the law passed last year relating to the electrical transmission of energy over long distances for industrial purposes.

Sydney.—In the prospectus issued this week of the Sydney Harbour Collieries, Limited, it is mentioned that it is proposed to sell the small coal for steam-raising purposes in connection with the electric lighting of Sydney, New South Wales.

Utilisation of Refuse.—In the course of a lecture delivered last week by Mr. P. Fyfe, sanitary inspector of Glasgow, the speaker gave an outline of a system under which the city refuse could be utilised for raising steam in connection with electric lighting.

National Exhibition.—Preparations are being made to hold a National Exhibition of Industry and Fine Arts in the city of Mexico, to be opened on April 2, 1896. Though the exhibition is termed national there will be a foreign department, to which it is expected that foreign nations will contribute.

Protection of Electrical Conductors.—A description, together with illustrations, is given in the *Elektro technische Zeitschrift* of February 21 of a device introduced by Messrs. Richard Hegelman, of Erfurt, as an auxiliary to lightning protectors, so as to safeguard from the effects of heavy currents conductors carrying weak currents.

Powdered Lead Accumulators.—Referring to the article on this subject published in our last issue, Mr. G. Straus, of 130, Queen Victoria-street, E.C., writes that he is the sole agent for the United Kingdom for the patentees, and that he is open to entertain proposals for the manufacture of the batteries or for disposing of the patents.

United States Patent Law.—The Supreme Court in Washington, in giving its decision on Monday in the Bate refrigerator case, held that the date of the issue of a patent, and not the date of application for such patent, determines whether patent rights in the United States expire simultaneously with the patent rights secured abroad.

Madras Electric Tramways.—A trial trip with a car was made recently from the power station at Egmore as far as the Madras Ice Factory. The *Indian Engineer* states that the car was in charge of Mr. Gadsby, the electrician of the company, who fitted the car with small temporary lamps. The car ran at the rate of about eight miles an hour.

Lecture.—An interesting lecture on recent advances in electrical applications was delivered on Monday at Stoke Newington by Mr. Fred H. Taylor, A.I.E.E. The lecturer dealt with heating and cooking by electricity, transmission of power, electric bleaching, electric welding, traction, signalling through space, electrically-operated musical instruments, etc.

Northern Society of Electrical Engineers.—A meeting of this society will be held on Monday next, the 11th inst., at the University College, Liverpool, commencing at 7 p.m. Mr. F. G. Baily, M.A., member, who will read a paper on "The Scientific Principles of Electrical Engineering," will allow his laboratory to remain open for the inspection of members previous to the meeting.

Institution of Civil Engineers.—The monthly ballot on Tuesday resulted in the election as members of Messrs. A. Crombie Humphreys, Westminster; Basil Mott, A.R.S.M., Stockwell; F. J. Sprague, New York; and A. W. Willet, L. and N.W. Railway; and the associate members elected included the names of Messrs. John Hesketh, of Blackpool, and H. Field Parshall, of Westminster.

Private Bill Legislation.—The Standing Orders Committee have decided to dispense with the standing orders in the case of the petition of the Cork and Fermoy Railway Company and of the petition of Baron Ardilaun against the Dublin United Tramways Bill. The Vestry of Lambeth have presented a petition against the proposal of the City and South London Railway Company to extend the time for carrying their underground electric railway forward to Clapham.

Royal Institution.—Among the members elected at the meeting on Monday were the Duke of Newcastle, Lieutenant-Colonel W. W. Rawes, R.A., Dr. Marmaduke Prickett, and Messrs. G. S. Albright, E. G. Betts, R. A. Bray, M. Bullock, G. Bywaters, G. F. N. Clay, C. S. Dickson, J. J. Elliott, J. Garvie, F. L. Harris, E. G. Harrison, S. C. Hogg, E. Law, G. H. Ogston, B. P. Portal, S. J. Portal, W. T. Shaw, J. H. Skelton, J. J. Walker, W. H. Walker, and A. F. Walter.

Storage Battery Traction.—Following the example of London, Paris, and Brussels, Berlin is now to be the scene of experiments with accumulator cars. The tests are to be made on the line from Moabit to Grossgörschen-

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strasse. Brussels, however, is not content with the unsatisfactory results obtained with the Julien system a few years ago, as is shown by the fact that a commission, consisting of officials of the Belgian State Railways, have inspected the Hagen Accumulator Works, and propose to introduce the zinc-copper batteries into Belgium for traction purposes.

Institution of Engineers and Shipbuilders.—The sixth general meeting of the present session of the North-East Coast Institution of Engineers and Shipbuilders will be held in the lecture hall of the Subscription Literary Society, Fawcett-street, Sunderland, on Tuesday next, the 12th inst., at 7.40 p.m. The discussion will be concluded on Mr. W. C. Mountain's paper on "The Design and Efficiency of Plant for the Transmission of Power by Electricity," and Mr. Henry Foster's paper on "The Application of the Electric Arc to Machinery and Boiler Repairs" will be discussed.

Telegraphic Interruption.—Not for years, the *Daily News* states, has telegraphic working with the Continent suffered from such a series of mishaps as that which has marked the present winter. On Tuesday it was reported at St. Martin's-le-Grand that the cable from Beachy Head to Dieppe had been severed, this being the fifth cable to break down within a period of only a few months. Continental telegrams had for a considerable time past been subject to delay on account of the few wires available, and the consequent necessity of diverting the traffic over indirect routes, and this latest casualty has added seriously to the difficulty of prompt despatch.

Explosions in Underground Mains.—The following letter from Mr. L. Epstein appears in the *Standard* of yesterday: "A possible explanation for the deposit of the metallic sodium, which, according to Major Cardew's report, has caused the recent explosions, may be found in the following hypothesis. Assuming that the glazing of the earthenware insulators has been produced by the usual material—viz., common salt (which forms a silicate of sodium with the unglazed material)—is it not possible that the leakage current between positive and negative mains, across the earthenware insulators, sets up electrolysis, resulting in the deposition of the metal sodium from its silicate?"

Determination of the Resistance of Electrolytes.—Prof. G. Kohlrausch criticises in the *Zeit. Physikal. Chem.* the method employed by Wildermann, an abstract of which is given in the *Journal* of the Chemical Society. The author is of opinion that the telephone method with alternate currents can be employed for much higher resistances than those examined by Wildermann, and is more convenient and simple than the method of the latter, which involves the use of strong batteries. In the cases of much higher resistances, 100,000 ohms and more, he does not consider Wilderman's method sufficiently accurate to render its application useful.

Forthcoming Lectures.—A special course of four lectures on electric light wiring will be delivered in the Heriot-Watt College on Monday evenings at seven o'clock, commencing on Monday next, the 11th inst., by Mr. R. Mullineux Walmsley, D.Sc., F.R.S.E., etc., professor of electrical engineering. The points considered will be those of importance to wiring contractors and to householders and others who propose to take advantage of the public supply of electric current by the Edinburgh Corporation. The first lecture will deal with conductors and circuits (rules for safety); the second with positions and fixing of conductors; the third with switches, fuses, and other small fittings; and the fourth with lampholders, brackets, and electroliers.

Terrestrial Magnetism.—The Royal Astronomical Association listened last week to a paper by Mr. Adams on "The Connection between Variations of Terrestrial Magnetism and Solar Surface Disturbances." Father Cortie (Stonyhurst Observatory) said that probably the sun-spots were only one manifestation of some agency at work in the sun. Though Lord Kelvin had, he believed, proved mathematically that it was impossible that outbursts on the sun could affect the earth magnetically, yet it was possible that both the solar disturbances and the disturbances of terrestrial magnetism might be effects of one cause. He had found that it was spots of a particular kind that accompanied magnetic storms, the position of the spot having no effect.

The Proposed Hawaiian Cable.—A telegram from Washington on Monday stated that the Senate has passed a resolution declaring that it still adheres to its amendment voting 500,000dol. for the Hawaiian cable, but that the House of Representatives persists in refusing to agree to it. In opposing the cable project in the Senate, Mr. Pettigrew, member for South Dakota, said: "Let Great Britain lay the cable; there is no reason to fear her." Mr. Morgan, in supporting the scheme, declared that Great Britain proposed to extend her dominion to Hawaii, and opposition to the cable meant only that the United States should yield to Great Britain to enable the latter to obtain the dominion. A subsequent despatch states that the Senate has withdrawn the amendment to the Diplomatic Appropriations Bill providing for the sum of 500,000dol. for the laying of a cable to Hawaii, thus definitely killing the project.

Electric Athletes.—A festive throng gathered on Friday at the Holborn Town Hall, a considerable portion of those present being members of the Electric Athletic Association in connection with the Central Telegraph Office, St. Martin's-le-Grand. The occasion was the annual distribution of prizes, together with an attractive entertainment made up of a long programme of music. The association consists of several of the clubs which, until a couple of years ago, had each a separate existence in connection with St. Martin's-le-Grand and its branches, but which were then amalgamated. The Postmaster-General (Mr. Arnold Morley, M.P.) was unable to be present, but among those who attended were Mr. Fischer, Mr. W. H. Preece, Mr. Lewin Hill, Mr. J. T. Hill, Mr. A. Askins, Mr. W. Wright, Mr. A. J. V. Adams, Mr. G. C. Newbury, the hon. general secretary and treasurer, Mr. F. J. Gilliver and Mr. E. Menzies, hon. assistant secretaries, etc.

Railway Rates.—The President of the Board of Trade stated, in reply to a question in the House of Commons on Monday, that about 1,800 complaints had been filed against increased railway rates by traders. Many of these, however, contained complaints from a number of traders against more than one railway company, and in most of them a number of rates was involved. The principal permanent officers of the Department had been engaged in dealing with the cases, but the pressure of work was so great that he had appointed Mr. Pelham, who was recently employed in connection with the revision of canal tolls and charges, to assist the Department. The Board of Trade were using their best endeavours to consider those complaints as expeditiously as possible in order that in those cases in which no amicable settlement could be arrived at, traders might be able to lodge their complaint as soon as possible with the Railway Commissioners.

Personal.—Mr. Frank B. Lea will be glad if correspondents will address him at 2, Rue de la Republique, Rouen, where communications may be sent to him for the next few months, during the conversion of the Rouen

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tramways to electric traction. Mr. Lea is acting as resident engineer for the Tramways Electric Traction Company, Limited, who have a controlling interest in the Rouen system.—Mr. H. W. Kolle resigned on the 1st inst. his position as chief of the staff of Messrs. Ferranti and Co., Limited, in order to take up an engagement with the Babcock and Wilcox Company. As a mark of great esteem, a handsome massive silver salver was presented to Mr. Kolle by the employés, the presentation being made in a kind speech by Mr. Ferranti, who expressed regret at his leaving and best wishes for success.—Mr. A. S. Blackman, who has been in charge recently of the Aberdeen station, has now been appointed electrical engineer in place of Mr. Ruthven Murray, who resigned.

Light Railways.—It is stated that in the Bill which the President of the Board of Trade hopes to introduce this week, the Government will propose to give effect to the principal suggestions made by the committee of the recent conference on light railways. The measure will enact that proposals for the construction and working of light railways and tramways, especially in the case of lines built through sparsely-populated and agricultural districts, should be submitted in the first instance to the county council (with exceptional provisions as to large municipalities). In cases of compulsory acquisition of land, the report continues, there is to be a power of appeal to the Board of Trade. If any doubt arises as to whether a railway is a light railway, to be dealt with locally, or is a scheme which should properly be dealt with by Parliament, the Board of Trade is to determine the question. No provisions are made in the Bill as to the gauge of the proposed light railways, which may differ in different parts of the country, and no proposal is made to empower local authorities to contribute funds towards undertakings of that character.

Metric System of Weights and Measures.—The Select Committee of the House of Commons on the subject of weights and measures sat again on Tuesday, Sir H. Roscoe presiding. Mr. Chaney, of the Standards Department, Board of Trade, gave further evidence. He stated that the Board of Trade were authorised to verify metric weights and measures for purposes of science and manufacture, but not for trade. A manufacturer might for the purposes of his manufacture use metric weights and measures, but, on the other hand, he was liable to the consequences of his act if he used them for the purposes of trade. The inspectors had power to interfere with any existing weights of illegal denomination. Mr. Amos Dowson, C.E., chairman of committee of the New Decimal Association, referred to the educational aspect of the question. The scholars in our primary schools were being taught the principles of the metric system on the assumption, as he observed, that it would be adopted in this country. He gave some curious examples furnished by the secretary of the Nottingham and Midland Merchant Traders' Association and others of discrepancies in existing local standards. The witness also gave it as his opinion that the adoption of the metric system would be an advantage to our foreign trade. Our merchants were placed at a disadvantage because foreign customers preferred to deal according to the metric system, with which they were familiar.

Institution of Junior Engineers.—A number of the members of this institution availed themselves on the 23rd ult. of the opportunity afforded by the president, Mr. Alexander Siemens, for visiting Messrs. Siemens Bros. and Co.'s works at Woolwich. Special arrangements had been made for their guidance over the extensive works, which cover an area of 7½ acres, and the occasion was rendered exceedingly interesting in every way. The new and old dynamo shops, the milling, bobbin, fitters', and rubber shops, the central power and lighting station, the switchboard erecting-room, the cable shop, tank-houses, lead-cable shop, cable testing, instrument calibrating, and show rooms were seen. At the conclusion of the inspection, the members were hospitably received by the president, who expressed the pleasure he felt in meeting them, and the chairman, Mr. H. J. Young, conveyed the thanks of the institution for the facilities extended in connection with the visit. On Friday last a meeting of the institution was held at the Westminster Palace Hotel, Mr. Young presiding, when a paper on "Locomotive Repairing Work" was read by Mr. A. H. Newsam Smith, member, of the Great Northern Railway repairing shops, King's Cross. By permission of Mr. S. W. Johnson, locomotive superintendent, the members of the institution will visit on Saturday next the goods station and depôt and repairing shops of the Midland Railway, at St. Pancras and Kentish Town.

Electrolytic Dissociation.—Mr. S. Tanatar, in the *Zeit. Physikal. Chem.*, an abstract of which appears in the Chemical Society's *Journal*, says that the decrease of conductivity of salts by the addition of alcohol is ascribed, not to a decrease in the dissociation, but to the increase of the ion friction. Addition of alcohol, however, also caused a decrease in the inversion velocity of sugar by salts, although this is dependent on the dissociation only. The author, therefore, attempts to estimate, by means of the thermal effects, the dissociation changes caused by alcoholic dilution. In all cases the thermal effects due to the water alone are observed simultaneously, and allowed for in the results. The addition of a 2N solution of hydrochloric acid to an equal volume of alcohol produces a heat absorption of only 0·137 Cal., so that the 2N solution in water and the 1·03N solution in 44 per cent. alcohol appear to be approximately equally dissociated. The addition of 300c.c. alcohol to 250c.c. of a 2N solution produced a development of about 1·02 Cal., apparently indicating increased dissociation. Potassium chloride dissolved in alcohol gives rise to a greater heat absorption than in water, the quantity being determined, both indirectly and directly, with concordant results. This effect is not an exceptional one, the same result obtaining with alcoholic solutions of potassium nitrate, sodium chloride, cane sugar, acetic acid, and methylic alcohol, whilst it is also noticeable that the freezing point depression with potassium chloride is greater in dilute alcoholic than in aqueous solution.

Electric Traction at Bristol.—The construction has been commenced this week of the trolley line from the present terminus at St. George to Kingswood, where it will end near the King's Arms Hotel. Many months have been spent in making preparations for the work, particularly in dealing with frontages and widening the road, so as to meet the Board of Trade requirements, and to provide double lines as much as possible. Now everything is ready the line will be rapidly constructed. The contract for the electrical equipment of the line between Kingswood and Old Market-street has been let to the British Thomson-Houston Company. The existing depôt of the Bristol Tramways Company at St. George's is to be used for a generating station, and the alteration and reconstruction of the buildings necessary to receive the plant have been entrusted to Mr. A. J. Beavan. Mr. A. Krauss has accepted the contract to make the line between St. George's and Kingswood, and to do the necessary relaying and alterations of the present track from St. George's to Old Market-street. In Old Market-street the proposal is to place ornamental standards in the centre of the road, between the outward and inward lines, to carry double brackets of an ornamental type. If deemed advisable,

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these standards may be used by the Corporation for their arc lamps. Everything was ready on Monday morning to make a start with the extension of the line from the St. George's terminus. The alteration of the existing line between St. George's and the city is to be taken in hand within a month, and its adaptation will go on concurrently with the construction of the new section of the line. The doubling and bonding are to be done chiefly at night, so that the traffic may not be interfered with. The major portion of the electrical plant is being imported from America. The cost of the whole work and appliances will be £50,000. The cars are to carry 50 passengers, to have outside garden seats, and to be illuminated outside and inside by electricity, the light to be sustained by means of storage cells, while the cars travel downhill by gravitation. The directors of the company are considering the advisability of introducing stopping-places, so as to save time and to ensure punctuality.

Electromotive Force of an Iodine Cell.—A paper on this subject was read recently by Mr. A. P. Laurie, M.A., before a meeting of the Chemical Society. A cell consisting of a zinc and platinum plate, immersed in a solution of iodine in potassium iodide, gives a definite and constant E.M.F., the zinc being dissolved at the expense of the iodine surrounding the platinum plate. On diminishing the strength of the iodine solution the E.M.F. gradually falls off, the rate increasing as the iodine becomes very dilute—the E.M.F. for a 0·1 per cent. solution being 1·460 volts, and for a 0·001 per cent. solution 1·369 volts. If potassium iodide free from iodine is used, an E.M.F. of about 1·172 volts is obtained. This value is uncertain, and varies for different platinum wires and at different times for the same platinum wire, the highest value being obtained with a wire boiled in soda, then in nitric acid, then washed, and finally heated white hot. If this wire, however, is left in the solution it gradually falls in E.M.F. to about the value given above. On adding a trace of iodine, 0·0001 per cent., the E.M.F. at once rises to about 1·320 volts, the reading differing slightly for different wires, and on increasing the amount of iodine the E M.F. goes on rising, the readings rapidly approximating until before 0·001 per cent. is reached the readings are all the same. Above this value the E.M.F. rises more slowly, but with regular movements, consequently the E.M.F. becomes a measure of the strength of the solution. The author proposes to use these results for measuring the rate of diffusion of very dilute solutions of iodine, and has made more preliminary experiments with the view of doing this. On diffusing a solution of 0·01 per cent. iodine from a short glass tube, with a platinum wire inserted in the closed end, into a mixture of potassium iodide, and taking readings of E.M.F. every half hour, a very regular curve was obtained showing the gradual diminution of the strength of the iodide solution, and in substituting cadmium for potassium iodide as the solvent, results were obtained so nearly agreeing that apparently the iodine is diffusing independently of the potassium iodide or cadmium iodide molecules. The author is now engaged in trying to measure the actual rate of diffusion and the relation between the rate of diffusion and the temperature of the solution. Incidentally the results show that determinations of the E.M.F. between metals and solutions require in certain cases to be made with considerable care, if the results are to be of any value.

Electrical Communication with Lighthouses.—On the Board of Trade vote, in the House of Commons on Tuesday, for £2,500 for the Mercantile Marine Fund (grant in aid), Sir E. Clarke said the vote was in aid of the expenditure on electrical communication with lighthouses. Nearly three years since the House accepted a resolution in favour of establishing electrical communication with the lighthouses of the country, and a Royal Commission was appointed, which had made two reports upon the matter, and recommended what was looked upon as a limited scheme. The whole sum required had been put at from £200,000 to £300,000. So far only £24,000 had been voted. Mr. A. C. Morton said that he found that the telegrams from lighthouses to the shore as to the locality of wrecks were communicated by the coastguard to the National Lifeboat Association's stations, and were withheld from volunteer lifeboat crews. This was because the first boat to reach the wreck received salvage. He moved to reduce the vote by £1,000. Mr. Bryce said that he was much concerned to hear that anything of the kind had taken place. Clearly every opportunity ought to be given for saving life, and to conceal necessary information would be very wrong. He could only speak for the Board of Trade, and not for the stations which were under the Postmaster-General; but with that limitation he would have enquiries made. As to the point raised by the hon. and learned member for Plymouth, this £2,500 was really a revote of what had been voted in previous years. The works were not begun in time, and the money had to be refunded to the Treasury. The amendment was withdrawn. Sir E. Clarke called attention to an answer given by the right hon. gentleman in June last with regard to the work then completed. Mr. Bryce said that the Gunfleet, the Haisborough light-vessel, and the Tuskar Rock lighthouse had been dealt with, and that three other lights still remained to be done of those to which the money had been devoted. Mr. Hanbury asked what control the Board of Trade would have over the spending of this money. Mr. Bryce said this money was not specially voted or earmarked for the first time. There had been two preceding years in which these special grants had been made. The whole thing had arisen out of the appointment of a commission which recommended that electrical communication should be established in certain cases. The Board of Trade had endeavoured to carry out these recommendations, and in two preceding years Parliament had voted special money for the purpose. It was quite distinct from the Mercantile Marine Fund, the affairs of which were being investigated by a committee presided over by Mr. Courtney. The vote was then agreed to.

Inspection of Electric Light Installations.—Under the auspices of the Chambre Syndicale des Industries Electriques, the Bureau de Contrôle has become an important institution in Paris, exercising, as it does, a kind of paternal government over those private electric light installations the owners of which are members of the bureau. In return for an annual payment the bureau inspects and tests the installations, and for this purpose visits are made and reports on the condition of the installations are drawn up and forwarded to the subscribers. Although under the patronage of the Chambre Syndicale, which nominates the manager and deals with the regulations, the bureau is entirely independent in the carrying out of its work. In order to ensure impartiality in its operations, the manager is forbidden to act as a contractor or manufacturer of electrical appliances, and to possess any interest whatever in any contracting or manufacturing concern. The bureau undertakes, on the ordinary terms, to make two examinations yearly of the installations, these including tests of the insulation and of the meters. In case of any failure the members of the bureau are requested to immediately inform the manager of the bureau, who at once sends an inspector to ascertain the cause and remedy the matter. Tests of the efficiencies of dynamos and

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accumulators and of measuring instruments are also conducted by the bureau. The annual charges, which are based upon the number of incandescent lamps installed, an arc lamp being considered as five incandescents and each motor or dynamo as 10 lamps, are as follow:

	s.	d.
10 lamps or less, a fixed rate of	4	0
10 to 20, per lamp	0	4¾
20 „ 23, fixed charge.....	8	0
23 „ 50, per lamp	0	4½
50 „ 56, fixed rate.....	18	0
57 „ 100, per lamp	0	4
100 „ 115, fixed charge	32	0
116 „ 200, per lamp	0	3½
200 „ 233, fixed rate	56	0
234 „ 500, per lamp	0	3
500 „ 600, fixed charge	120	0
600 „ 1,000, per lamp.....	0	2½
1,000 „ 1,250, fixed rate	200	0
1,250 upwards, per lamp	0	2

An additional visit to a consumer is charged at the rate of one-third of the annual subscription, with a minimum of 4s. A meter is verified for 16s., and the payment for the labour of an employé is 16s. for half a day and 24s. for a whole day. In cases where the services of the bureau are requisitioned by a non-subscriber, a charge is made at the rate of two-thirds of the annual fee which would have to be paid, according to the number of lamps installed, if the person had been a client.

The Government and Telephony.—The motion mentioned in our last issue for the appointment of a Select Committee to consider the proposed draft agreement between the Postmaster-General and the National Telephone Company, and report with reference to the monopoly which may thereby be created, the granting of telephone licenses to municipalities, and generally on the future policy of the Post Office with reference to the extension of the telephone service, was moved by Mr. Benn in the House of Commons on Friday. In doing so he contended that the agreement could not be regarded as binding, because one of the parties to it, the New Telephone Company, had ceased to exist, having been absorbed by the National Telephone Company, and he submitted that a body which could thus buy out a competitor was at least not entitled to the most delicate treatment. Captain Bagot, who seconded the motion, said that if the present agreement were carried into law, there would be established a gigantic monopoly which would control the whole telephonic system of the country. The Postmaster-General said that the committee which investigated this question reported that the agreement should be submitted to Parliament. But he had spoken to several members of that committee, and they agreed that what was meant was that Parliament should be informed of what had been done. He had not promised that the agreement should be discussed. Any other course than that he proposed to follow would be a repudiation by the Government of the acts of their predecessors, and he could not consent that the agreement should be referred to such a committee. He was not responsible for the terms of that agreement, but he had tried honourably to carry it out. The agreement created no monopoly. The right was reserved by the Postmaster-General to enter into agreements with or grant licenses for telephones to persons, companies, or other bodies. The telephone system was no more local than the post or telegraph service, and to grant municipal licenses would be to treat it as a local and not as an Imperial matter. The Government were, however, prepared to assent to the appointment of a committee to consider the question as to whether the present service was adequate, and whether it might be supplemented by municipal service or otherwise. Sir John Gorst said the policy of the agreement was embodied in the Telegraph Bill, and by passing the Bill Parliament had endorsed that policy. The intention of the late Government was not to create a monopoly, but to prevent the creation of a monopoly. Mr. Goschen, as one largely responsible for the agreement, said the rights of the Government were reserved in the strictest possible way. The power of granting licenses to other companies or to municipalities remained with the Government. The motion as modified to meet the suggestions of the Postmaster-General was agreed to.

Electrical Precipitation from Cyanide Solution. The Siemens and Halske process for the recovery of gold has now been in operation for some months at the Worcester mines of the Rand Central Reduction Company, South Africa. This system was described recently by Mr. A. von Garnet, in a paper read before the Chemical and Metallurgical Society of South Africa. The author, speaking of the working results at Worcester, said there are now in use five leaching vats of 2ft. in diameter with 10ft. staves, each holding 2,700 cubic feet. One tank is discharged and filled each day. The strong solution used contains from ·05 to ·08 per cent. cyanide, and the weak washes ·01 per cent. The actual extraction of fine gold has averaged 70 per cent., while the consumption of cyanide has been ¼lb. per ton of tailings treated. The precipitation plant consists of four boxes 20ft. by 8ft. by 4ft. Copper wires are fixed along the top of the sides of the boxes, and convey the current from the dynamo to the electrodes. The anodes are iron plates 7ft. long, 3ft. wide, and ⅛in. thick. They stand on wooden strips placed on the bottom of the box, and are kept in vertical position by wooden strips fixed to its sides. In order to effect circulation in solutions passing through the box, some of the iron sheets rest right down on the bottom, while others are raised about 1in. above the level of the solution, thus forming a series of compartments similar to those of a zinc-box; the difference being that the solution passes alternately up and down through successive compartments. The sheets are covered with canvas to prevent short-circuit. The lead sheets (cathodes) are stretched between two iron wires, fixed in a light wooden frame, which is then suspended between the iron plates. The boxes are kept locked, being opened once a month for the purpose of the "clean up," which is carried out in the following manner: The frames carrying the lead cathodes are taken out one at a time. The lead is removed and replaced by a fresh sheet, and the frame returned to the box, the whole operation taking but a few minutes for each frame. By this means the ordinary working is not interrupted at all, and the cleaning out of the boxes, which is necessary in the zinc process, is only required at very long intervals. The lead, which contains from 2 to 12 per cent. of gold, is then melted into bars and cupelled. The consumption of lead is 750lb. per month, equal to 1½d. per ton of tailings. The working expenses, including filling and discharging tanks, comes to 3s. per ton. When working on a larger scale the expenses will, of course, be reduced. After the facts mentioned in this paper it will, no doubt, be conceded that electrical precipitation has emerged from its experimental infancy and grown into healthy manhood, and proved itself to be a technical and commercial success, and that it is in every respect at least as good a method of precipitation as the zinc process. Any way, it exists as a tangible fact, which cannot be explained away by argument or ignored by commercial men, who require the best work at the cheapest rate. Sufficient has been said to place the Siemens and Halske process within the category of practical precipitants of gold from cyanide solutions.

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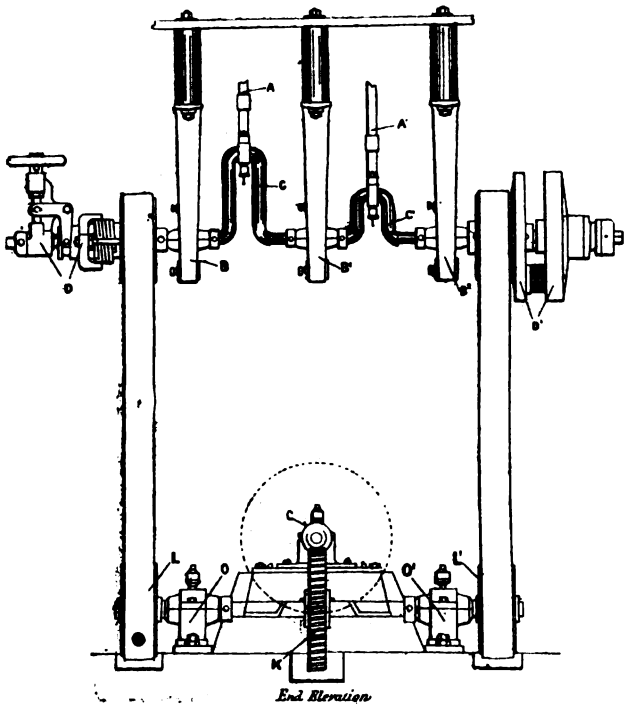
ELECTRIC POWER FOR ORGAN-BLOWING.

In our last issue we gave an abstract of a paper read recently by Mr. Walter J. Fryer, A.I.E.E., on "The Practical Applications of Electricity," before the Institution of Junior Engineers. The author referred, among other matters, to an installation which he had carried out, where electric power is used for the blowing of organ bellows. The motor employed was described in our last issue, and we now give some details of the gearing and clutches, together with an end elevation of the plant.

Referring to the illustration, A, A^1, are the rods connecting the two cranks with the lever of the bellows—A^1 to the heavy pressure, and A to the light pressure; B, B^1, B^2 are hangers with adjustable bearings; C is a 1¼in. crankshaft with 10in. throw; C^1 is a similar crankshaft with a 5in. throw to the crank (these two shafts act quite independently of one another, as they are divided in the centre); D is a clutch pulley made specially for this particular plant by the Coil Clutch Company. It works evenly and well, and consists of a solid cast cone of steel upon which the pulley is keyed. This is loose upon the shaft. A coiled steel spring fits over the cone, and is held by a cast-iron U-shaped clamp on one side and



two L-shaped bolts on the other. The clamp runs horizontally upon a feather, and has a circular groove turned out of it at the end, into which fits a split gunmetal collar attached to a right-angle lever pivoted at the corner and shaped at both ends so as to form forks, one of which grips the gunmetal collar and the other grips the tapped socket, working up and down the screw as the handwheel is turned. The clutch can be so adjusted that the pulley can be caused to run loose at any desired horse-power. The operation is as follows: By turning the small wheel round from left to right the right-angle lever presses against the clamp, moving it to the right, forcing the spring on to the cone, and this gripping the pulley causes the crankshaft C to revolve. The pressure of the spring upon the cone is so adjusted that as the bellows A become full the pulley slips, and the whole of the power can then be utilised for working the opposite crankshaft, C^1. As the bellows become partly empty the spring again grips the cone, and the bellows are once more filled. An eighth of a turn of the small regulating wheel is all that is necessary about once every six months, in order to allow for the wear of the spring and cone. The arrangement works in an automatic manner, without the slightest jerk, and quite noiselessly.

A clutch of entirely different construction, practically consisting of two pieces, is shown at D^1. The half upon which the pulley is cast runs loosely upon the shaft, and is held in position by two collars; projections 3in. long by ½in. in width are cast upon the side of the pulley. The other half is fixed to the shaft by means of a feather, and has 40 bunches of elastic metal teeth 3in. long by 2in. wide attached to it. These teeth engage with the metal projections on the opposite side, and thus cause the shaft C^1 to revolve. The depth of the engagement of the teeth is regulated by means of a brass bush and locking nut. The pulley will then slip when overloaded—that is to say, when the bellows A^1 are full. The spaces between the teeth are filled up with tallow so as to deaden the noise as much as possible; but although this makes a perfect elastic coupling for ordinary use, as it goes into gear without the slightest jerk, it is not so suitable for this purpose as the one previously described. The sizes of both pulleys are 10in. by 4in., and they work at 50 revolutions per minute.

The motor, M, which was described last week, is of 3 b.h.p., capable of working up to 4½ h.p. for short periods; the speed is 2,000 revolutions per minute, and the length of shaft over all, 1ft. 8¼in. The lubrication is carried out by means of loose brass rings dipping into oil. The frequency is 100 cycles per second; the voltage 100; starting current about 68 amperes; current at full load, 41 amperes. The motor is connected on to the worm, G (which is cut out of the solid), by means of a cone coupling. The wheel, K, consists of 40 teeth, thus giving a speed of $\frac{2,000}{40}$ = 50 revolutions per minute to the pulleys, $L L_1$. The wheel is keyed to a 1¾in. shaft supported by two adjustable plummer blocks on sole-plates, $O O^1$, the 10in. by 4in. pulleys being keyed on to the outside of the plummer blocks, and the whole of the gearing is enclosed in an oil bath. The power is then transmitted by means of two double leather orange tan belts, travelling at 135ft. per minute.

INSTITUTION OF CIVIL ENGINEERS.

ELECTRIC TRANSMISSION OF POWER.

Two papers were read on Tuesday before the Institution of Civil Engineers dealing with the electrical transmission of power, Sir Benjamin Baker, K.C.M.G., vice-president, occupying the chair.

The first, on "Electrical Haulage at Earnoch Colliery," by Mr. Robert Robertson, B.Sc., M.I.C.E., opened with an account of the general features of the colliery and of those of its seams into which electric haulage had been introduced. The arrangements of the shafts and the capacities of the cage and coal-hutches were such that the daily output amounted to 1,200 tons. Details were given of the lengths and gradients of the main haulage roads in the Ell and Main coal seams, and of the two steam hauling engines operating those roads on the main and tail and endless-rope systems respectively. Electrical hauling engines had been introduced to drive endless ropes, and to replace horse traction between the main haulage roads and the working faces.

The electrical generating plant comprised a dynamo for supplying power to the electrical hauling engines, capable at a speed of 620 revolutions per minute of an output of 100 amperes at 490 volts. It was driven from a shaft coupled direct to two single-acting Westinghouse engines having cylinders 13½in. in diameter with a length of stroke of 12in. and developing together, when running at their normal speed of 350 revolutions per minute, 122 h.p. with a steam pressure of 50lb. per square inch. The electrical circuits were metallic throughout, and the conductors were highly insulated, being sheathed also in iron pipes in the shaft and supported upon insulators in the workings. The two electrical hauling engines, of which the main features were similar, were next described and illustrated. The motor of the engine in the Ell coal seam, when running at a speed of 770 revolutions per minute, developed 35 h.p. with a current of 76 amperes at a pressure of 400 volts. It was geared, through an intermediate shaft, to two pulleys with Hurd clips, each provided with a friction clutch and brake, by which the cables were driven at a speed of three miles per hour. The two cables were of stranded steel wire ¾in. in diameter, and, after passing over balance-wheels placed

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in recesses near the engines, operated circuits of 2,160 yards and 1,020 yards in length respectively. The cables were supported at intervals of about 30ft. along the roads by rollers 4½in. in diameter, and at the corners were passed over wheels 5ft. in diameter, mounted upon vertical axes below the level of the rails. The gradients were so arranged at the corners that the trains of trucks could there travel without aid from the ropes. In the Main coal seam a cable operated similarly a circuit 1,580 yards in length. The cables were driven continuously at a uniform speed, and the coal-hutches were attached to or detached from them by a Smallman clip.

The efficiency of the plant as compared with the horse traction, which it had replaced, was then considered. The electrical haulage system in the Ell coal seam was capable of a daily output of 400 tons. The daily output by horse traction had been 180 tons, and to increase this to 400 tons 30 or 40 horses would have been required, a number which could not have been employed in the available space without confusion. The daily output of the electrical haulage system in the Main coal seam, which was not yet working at its full capacity, was between 150 and 200 tons. The yearly working expenses of the two systems were compared upon the results of one and a half year's working, and were found to be £4,130 and £1,990 by horse traction and by electrical haulage respectively, showing that an annual saving of £2,140 had been effected by the latter. The total cost of the electrical installation had been £3,500.

In the second paper, "Water Power applied by Electricity to Gold Dredging," by Mr. Robert Hay, M.I.C.E., an account was given of plant which had been erected in New Zealand to utilise water power for generating electricity to be transmitted to motors operating a dredge in different portions of a distant river. The author pointed out that the transmission of water power by electricity in well-watered countries like New Zealand, rendered available deposits of gold in districts in which the scarcity of fuel would not permit of their being worked by other means. The plant described had been constructed for gold dredging in the River Shotover, the course of which was for the most part in rocky gorges through rugged country, accessible only by tracks cut down the leading spurs and gullies. The source of the water power and the method of its application were then described, and illustrated by a longitudinal section of the pipe line. The water was obtained at a creek one and a half miles distant from the dredging ground, and was brought by a race cut in the side of the hill, or in places where the ground was not suitable in a timber flume, to a pressure tank at a level of 524ft. above the pipes at the generator-house. From this tank to the Pelton wheel the water was carried in rolled-steel pipes constructed in lengths of 19ft. 6in., bolted together by wrought-iron flanges riveted to the pipes.

The prime mover of the generating plant was a 4ft. Pelton reaction waterwheel, upon the buckets of which the water from a nozzle 1½in. in diameter impinged at a pressure of 228lb. per square inch. This wheel drove two series-wound dynamos working at a normal speed of 700 revolutions per minute, each developing a current of 40 amperes at an E.M.F. of 650 volts, or together nearly 70 h.p. The dynamos were coupled in series, and to guard against damage from abnormal increase of current, a regulator was so arranged as to throw into the circuit an artificial load, in case of the current becoming from any cause three amperes greater or less than its normal amount. The conductors, of a length of two miles, were of No. 4 S.W.G. bare copper wire, and were supported upon insulators carried by cross-arms upon old 40lb. rails. The current was conducted to two motors in the dredge—one for driving a centrifugal pump, and the other for operating the buckets, winches, and revolving cylinder. These two machines were duplicates of the dynamos, and were coupled in series so that when the bucket motor was switched off, the pump motor absorbed the surplus power by increasing the speed of the pump and causing it to throw more water. The dredge was constructed for the most part of steel, and was capable, when operating at a depth of 20ft., of an output of 90 cubic yards per hour. The dredgings were delivered through a revolving screen for separating the stones and coarser material, upon baize tables set at an inclination of 1 in 12. Two 10-ampere arc lamps lighted the dredge at night, and were joined in multiple series with the motors, with suitable arrangements for their control. A table of particulars of the efficiencies of various parts of the plant was given. The cost of the installation and the weekly working expenses, £7,000 and £35 respectively, were also tabulated.

STEAM TRAMWAYS IN ITALY.

BY P. AMORETTI.

In a previous issue we referred to the paper contributed to the *Proceedings* of the Institution of Civil Engineers on this subject by Mr. P. Amoretti, manager of the Steam Tramway Association of Turin. We now give an abstract of the paper.

At the end of the year 1890, the length of steam tramways constructed in Italy was stated in the official returns as 1,575 miles, and about 300 miles have been constructed since that time. Owing partly to the commercial crisis through which Italy has recently been passing, and partly to the unsatisfactory results of the working of many of the lines, the rate of construction has much diminished since the close of 1890.

The existing network originated in the lines radiating from large centres, such as Turin and Milan; lines, originally terminating in the immediate suburbs, being extended to outlying points, until they met or crossed lines from other centres. At first these various lines were worked independently of each other, and their functions were limited to local traffic, but as the system extended joint working arrangements were made, and through traffic was provided for between the several lines and, where practicable, over the railway systems. This development was, of course, impossible where varying gauges had been adopted. About 36 tramway companies, working 1,365 miles, have since 1886 combined to form the Italian Tramway Association, by which a common basis of working is established and all administrative matters discussed and regulated.

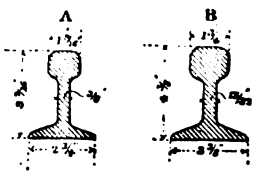

FIG. 1.

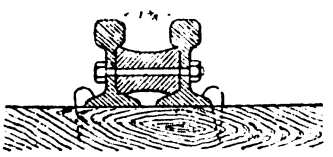

FIG. 2.

In the majority of cases the standard Italian railway gauge, 4ft. 8½in., has been adopted. The steel rails used are exclusively of the Vignoles type, fixed direct to the sleepers on straight lengths and on chairs when in curve. In towns guard rails are used to facilitate packing the metalling, the width for the flange of wheel being about 1⅜in. The rail generally adopted (Fig. 1 Type A) weighs 36lb. per lineal yard; but where the engines used weigh over 12 tons, or the traffic is very heavy, the section Type B, weighing 42lb. per lineal yard, is used. The sleepers are always of oak, which abounds in Italy, the dimensions for standard gauge lines averaging 4¼in. by 7in. by 7ft. 3in. long. The rails are secured to the sleepers with spikes, the use of coachscrews having shown very unfavourable results. Guard rails, Fig. 2, are used in nearly all cases of curves of less than 2½ chains (55 yards) radius. The points vary little from those on railways.

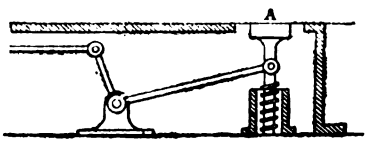

FIG. 3.

They are generally worked by levers with counterweights; but in towns where such an arrangement could not be adopted in the open street, the lever is contained in a cast-iron box flush with the ground level, Fig. 3, and is

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fitted with a foot-plate and counter-spring. The plate is thus kept in its normal position, flush with the opening at the ground level; but when pressed downwards by the foot, it operates the lever and moves the points.

In regard to curves and gradients, the one general guiding principle that has been followed appears to be simply to construct the line at all hazards. The articles of concession usually state that no curves shall have a radius less than 55 yards; but the exceptions granted have been so numerous that it may be said that no practical limit is recognised. It is the same with the gradients as with the

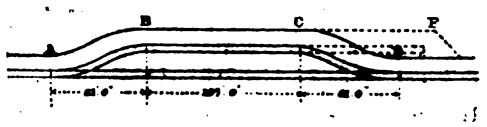

Fig. 4.

curves; in any case the limiting rate of inclination can, in view of the system of simple adhesive traction, only be considered as excessive. With but few exceptions—these being trunk routes, common to several lines—the steam tramways of Italy are all single lines, with passing places at such distances as are required by the extent of the traffic. These passing places, Fig. 4, are usually placed on the side away from the road, if an extra strip of land can be acquired for the purpose. Where shunting is of ordinary occurrence, or cars have to be left

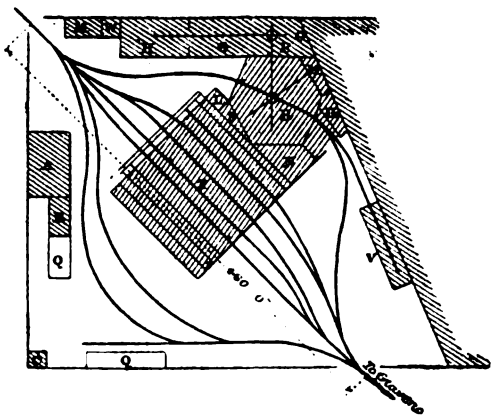

Fig. 5.

for loading or unloading, it is desirable to construct a short dead-end siding. So far as possible, these passing places are provided on public ground or at regular stations, as the tramway companies have no compulsory powers for the purchase of land.

The Turin station of the Turin, Orbassano, and Giaveno line is shown in Fig. 5. It is technically a terminal station,

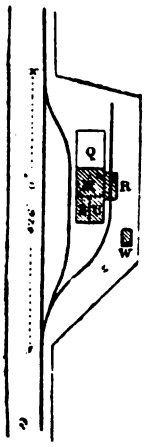

Fig. 6.

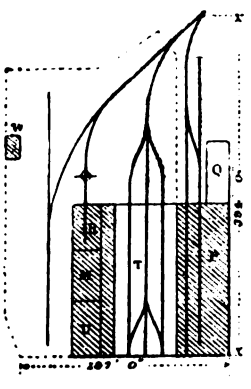

Fig. 7.

though the starting point is nearly 1,000 yards further towards the centre of the city, where it was impracticable to acquire the necessary ground. The letters on the plan indicate: A, booking-office; B, goods warehouse; Q, goods-sheds; T, carriage-shed; R, engine-shed; and M, V, F, G, and H, repairing-shops, forge, and stores. Fig. 6 is an example of a small wayside goods station at Piossasco. The passenger building (booking-office and waiting-room) is shown by S, U; M, Q, and R being respectively warehouse, goods-shed, and carriage lock-up. The terminal station of Giaveno, where there is in a small space a considerable traffic of both passengers and goods, is shown in Fig. 7. The references are: U, booking-office and waiting-room; R, engine-shed; T, roof over arrival and departure lines, forming carriage-shed; P, goods warehouse; and Q, open goods-shed.

If regular stations are of infrequent occurrence on the steam tram lines, the connections with private sidings are, on the other hand, very numerous. By the fact of their construction on the high roads the lines afford direct communication with farms, fruit gardens, dairies, mills, factories, ironworks, brickworks, limekilns, quarries, and mines in a manner unattainable on such a general scale by ordinary railways. The trucks are loaded direct, and run without any transfer straight to their point of distribution, while the materials required from the city by the works and factories are similarly brought to them with a minimum of expense in handling. The development of this important branch of traffic resources has induced the various companies to do their utmost to facilitate loading and unloading processes. The rolling-stock of the different companies varies greatly in its proportion to mileage. At

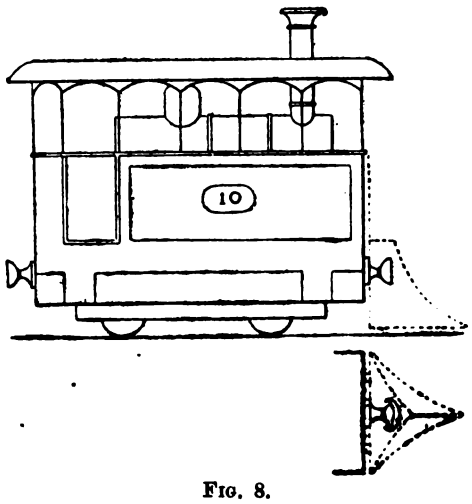

Fig. 8.

the nearest approximation to an average the number of engines is from 0·12 to 0·19 per mile of line worked, passenger cars from 0·3 to 0·6, and freight trucks from 0·3 to 0·9. The general appearance of the engine with its casing is shown in Fig. 8. The screen or casing hangs to within 4in. of the rail level. The total weight of the machine in full working order varies from eight to sixteen tons, the exceptional maximum being 20 tons. The diameters of the cylinders vary from 7in. to 11in., the usual type in 12 to 14 ton engines having a diameter of 9½in. The average distance of the axles from centre to centre is 5ft. 3in., with wheels 1ft. 11in. or 2ft. 2¼in. diameter. Neither condensers nor smoke consumers are adopted. Welsh coal is usually burnt, and wire spark-guards are fitted on the chimney. During the winter the plains in the valley of the Po, and to an even greater extent the lateral valleys, are frequently covered with a considerable

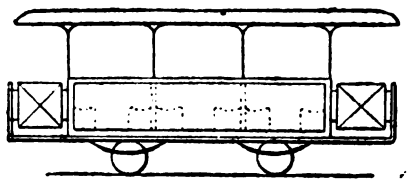

Fig. 9.

depth of snow; and to clear this, when the depth does not exceed 18in., a small snow-plough, shown by the dotted line, is fitted on the engine.

Passengers are conveyed in carriages (Fig. 9) providing 16 seats and 16 standing places, first class; or 24 seats and 16 standing places, second class; or a mixed type providing

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eight seats and eight standing places, first class, and 12 seats and eight standing places, second class. In a few cases longer carriages on two bogie frames have been tried, but, as a rule, the smaller carriages are preferred, as the train is made up more easily to suit the requirements of the moment. There is no general provision of separate luggage vans, but one compartment is usually reserved for the carriage of passengers' luggage. The ordinary carriages—*i.e.*, standard gauge—weigh on an average from 3 tons to 3½ tons, and the open cars 2 tons to 2½ tons, showing a great advantage in favour of the latter during the season when they can be worked. Goods trucks generally resemble those used on the railways, their capacity ranging from 6 tons to 8 tons, and their weight (empty) varying from 2½ tons to 3½ tons for open trucks, and from 3½ tons to 4½ tons for covered vans.

All the passenger cars and nearly all the freight cars on the steam tramways are provided with brakes, so that each conductor has one close at hand. Those usually employed are chain-brakes on the passenger cars and screw-brakes on the trucks. Continuous brakes are only adopted in a few instances. On some lines, where the companies are trying to get permission from the Government to run their trains at a speed exceeding the regulation 24 kilometres an hour, the proposal has been made to adopt continuous brakes; and this arrangement, now under consideration, will most likely be accepted by the Government.

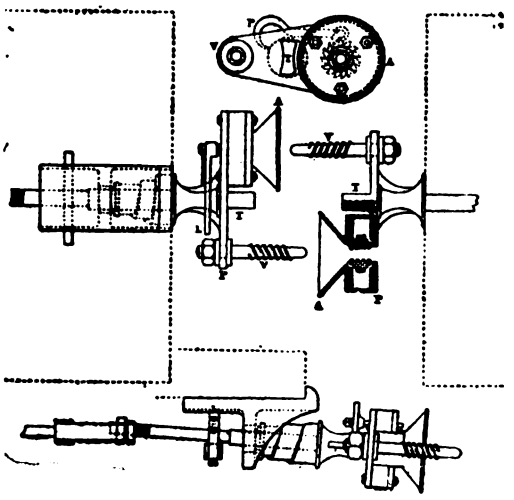

Fig. 10.

The vehicles are usually connected by a central coupling, but of late the Prada coupling (so named after its inventor) has been extensively used. This coupling is automatic in its action—that is to say, two vehicles coming into contact become at once coupled. Upon a plate, P (Fig. 10), is mounted at one end a double-threaded screw, V, and at the other end a conical guide cup, A, terminating in a collar in which is fitted a screw union revolving in one direction only while the levers, L, are in their normal position. With two cars similarly fitted, the screw, V, and the guide and union, A, of the one are respectively opposite the guide and union, A, and the screw, V, of the other. The screws, V, on coming into contact with the unions, are gripped home, and the connection remains perfect until the levers, L, are raised, when the unions are free to revolve in the opposite direction, and so to release the coupling screws. The system has now been working satisfactorily for several years. On the Italian steam tramways, it must not be forgotten that at least one telegraphic connection is compulsory between all stations and stopping places along the line. This regulation was enforced recently by the Government.

The original Government regulations for the trains to be run on public roads were:

Maximum weight of train, including engine	30 tons.
,, length ,, ,, ,, ...	100 feet.

An alternative regulation allowed four vehicles (each of about 20ft. length), and the engine about 17ft. These limits have since been extended, and for trains running at from 10 to 12 miles an hour six vehicles, in addition to the engines, are now allowed, while still greater latitude is given if the speed is reduced.

The nearest possible approximation seems to be from £1,280 to £1,920 per mile for cost of construction, of which amount about £960 is required for the permanent way, materials, and laying. The cost of land or of station buildings is, of course, not included in the above statement; it frequently works out at from £320 to £380 per mile, but it is practically impossible to arrive at any general average. In regard to rolling-stock, the cost of equipment varies from £450 to £570 per mile. Sundry items of supervision, compensation, workshops, telegraph or telephone, furniture, etc., come to from £100 to £200 per mile. The average total, therefore, as nearly as can be stated, is £2,600 per mile.

Leaving out of consideration some exceptional cases, both of bad and of good receipts, the average gross earnings are about £400 per annum per mile of line worked. The average of working expenses cannot be less than £125 per mile over flat country, or £160 per mile on hilly ground. The average of returns which the author has been able to analyse give, in round figures, £300 per mile—*i.e.*, 75 per cent. of the average gross receipts. The net earnings are therefore about £100 per mile, and the average dividends — *i.e.*, on ordinary shares — are about 3 per cent.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 250).

The combination of two horseshoes with common pole-pieces furnishes two further forms of field-magnet frames. Fig. 81 shows the horizontal double-horseshoe type, and Fig. 82 the vertical double-horseshoe type.

Machines of the former type, Fig. 81, are built by the United States Electrical Company (Weston), New York; the Brush Electrical Company, Cleveland, O.; the Ford-Washburn Storelectric Company, Cleveland, O.; the Western Electric Company, Chicago, Ill.; the Fontaine Crossing and Electric Company ("Fuller"), Detroit, Mich.; by Crompton and Co., London, England; by Laurence, Paris, and Scott, England; and by Schuckert and Co., Nuremberg, Germany.

The latter form, Fig. 82, is employed in dynamos of Fort Wayne Electric Corporation ("Wood"), Fort Wayne, Ind.; La Roche Electric Works, Philadelphia; Granite State Electric Company, Concord, N.H.; Electric Construction Corporation (Elwell-Parker); and Crompton Company, London, England.

If one or both the pole-pieces of a consequent-pole double-magnet type are prolonged in the axial direction—that is, toward the armature—and the winding is transferred from the cores to these elongated pole-pieces, then a type is obtained in which the magnet frame forms a closed iron wrappage with inwardly protruding poles. Forms of this feature are known as iron-clad types, and according to the number of magnets and to their position are single-magnet and double-magnet, horizontal and vertical iron-clad types.

Fig. 83 shows the horizontal iron-clad type, having two horizontal magnets. It is used by the General Electric Company ("Thomson-Houston arc light type"), Detroit Electric Works, Detroit, Mich.; Eickemeyer Company, Yonkers, N.Y.; Fein and Co., Stuttgart; and Aachen Electrical Works (Lahmeyer), Aachen, Germany.

A modification of this type consists in letting the poles project parallel to the shaft, one above and one below, or one on each side of the armature; the only magnetising coil required in this case will completely surround the armature. This special horizontal iron-clad form, which is illustrated in Fig. 84, is realised in the Lundell machine, built by the Interior Conduit and Insulation Company, New York.

In Figs. 85 and 86 the two possible cases of the vertical single-magnet iron-clad type are depicted, the magnet being placed above the armature in the former and below the armature in the latter case. The single-magnet iron-clad

* From the *Electrical World* (New York).

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overtype, Fig. 85, is adopted in the machines of the Muncie Electrical Works, Muncie, Ind., and in the battery fan motor of the Edison Manufacturing Company, New York. Machines of the single-magnet iron-clad undertype, Fig. 86, are built by the Brush Electrical Engineering Company ("Mordey"), London, and by Stafford and Eaves, England.

The vertical double-magnet iron-clad type, Fig. 87, having two vertically projecting magnets, one above and one below the armature, is employed in machines of the Wenstrom Electricity Company, Baltimore; the Triumph Electric Company, Cincinnati, O.; the Shawhan-Thresher Electric Company, Dayton, O.; the Card Motor Company, Cincinnati, O.; the Johnson Electric Service Company, Milwaukee, Wis.; the Erie Machinery Supply Company, Erie, Pa.; and the Zurich Telephone Company, Zurich, Switzerland.

There are various other bipolar types, which, however, mostly are out of date, and therefore of very little practical importance. These can easily be regarded as special cases of the types enumerated above.

(b) Multipolar Types.—Multipolar field-magnet frames can have one or two magnets for every pole, or each magnet can independently supply two poles, or one single magnet, or two magnets may be provided with pole pieces of such shape as to form the desired number of poles of opposite polarity.

If the number of magnets is identical with the number of poles, the magnets may either be placed in a radial, a tangential, or an axial position with reference to the armature, and in the two first-named cases they may be put either outside or inside of the armature.

The radial outer-pole type is shown in Fig. 88; this form has been adopted as the standard type for large dynamos of the General Electric Company, Schenectady, N.Y.; of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa.; the Crocker-Wheeler Electric Company, Ampere, N.J.; the Riker Electric Motor Company, Brooklyn; the Stanley Electric Manufacturing Company, Pittsfield, Mass.; the Fort Wayne Electric Company, Fort Wayne, Ind.; the Eddy Electric Manufacturing Company, Windsor, Conn.; the Belknap Motor Company, Portland, Me.; the Shawhan and Thresher Electric Company, Dayton, O.; the Great Western Electric Company (Bain), Chicago; the Walker Manufacturing Company, Cleveland, O.; the Mather Electric Company, Manchester, Conn.; the Claus Electric Company, New York; the Commercial Electrical Company, Indianapolis; the Allgemeine Electric Company (Dobrowolsky), Berlin, Germany; the Oerlikon Machine Works, Zurich, Switzerland; Alioth and Co., Basle, Switzerland; the Berlin Electric Construction Company (Schwartzkopf), Berlin, Germany, and numerous others.

In Fig. 89 is represented the radial inner-pole type, which is used by the Siemens and Halske Electric Company, Chicago, Ill., and Berlin, Germany; by the Alsacian Electric Construction Company, Belfort, Alsace; by Naglo Bros., Berlin, Germany; by Fein and Co., Stuttgart, Germany; and by Ganz and Co., Budapest, Austria.

The tangential outer-pole type, Fig. 90, is employed by the Riker Electric Motor Company, Brooklyn; by the Baxter Motor Company, Baltimore, Md.; the Mather Electric Company, Manchester, Conn.; the Dahl Electric Motor Company, New York; the Electrochemical and Speciality Company, New York ("Atlantic" Fan Motor); and by Cuenod, Sautter, and Co. (Thury), Geneva, Switzerland; generators of this type are further used in the power station of the General Electric Company, Schenectady, N.Y.; and in the Herstal, Belgium, Arsenal.

Machines of the tangential inner-pole type, Fig. 91, are built by the Helios Electric Company, Cologne, Germany.

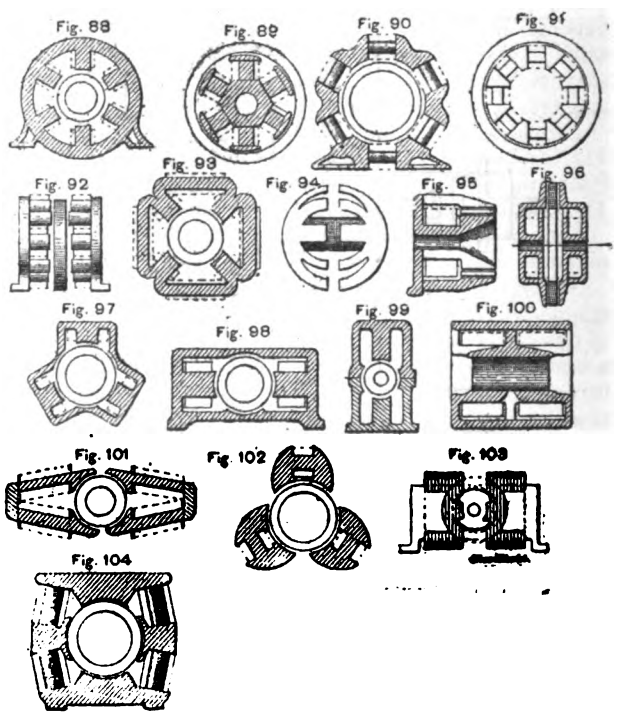
In the axial multipolar type, Fig 92, there are usually two magnets for each pole, one on each side of the armature, in order to produce a symmetrical magnetic field. This form is used by the Short Electric Railway Company, Cleveland, O.; Schuckert and Co., Nuremberg, Germany; Fritsche and Pischon, Berlin, Germany; Brush Electric Engineering Company, London, England ("Victoria" dynamo); and by M. E. Desroziers, Paris, France.

Fig. 93 shows the raditangent multipolar type, which is a combination of the radial and tangential outer-pole types, Figs. 88 and 90 respectively, and which is employed by the Standard Electric Company, Chicago, Ill.

If only one magnet is used in multipolar fields, the pole-pieces may be so shaped as to face the armature in an axial or in a radial direction. In the former case the axial-pole single-magnet multipolar type, Fig. 94, is obtained, which is used by the Brush Electrical Engineering Company (Mordey), London, England; and by the Fort Wayne Electric Company (Wood), Fort Wayne, Ind.

In the latter case the outer-inner pole single-magnet type, Fig. 95, results, in which the pole-pieces may either all be opposite the outer or the inner armature surface, or alternately outside and inside of the armature; the latter arrangement, which is the most usual, is illustrated in Fig. 95, and is employed by the Waddell-Entz Company, Bridgeport, Conn., and by the Esslingen Works, Wurtemberg, Germany.

If two magnets furnish the magnetic flux they are placed concentric to the armature and the two sets of pole-pieces so arranged that adjacent poles on either side of the armature are of unlike polarity, but that poles facing each other on opposite sides of the armature have the same polarity. Such a double-magnet multipolar type is shown in Fig. 96; it is that designed by Lundell, and built by the Interior Conduit and Insulation Company, New York.



In giving the yoke of the radial multipolar type, Fig. 88, such a shape as to form a pole-piece between each two consecutive magnets an iron-clad form is obtained, having alternate valient and consequent poles, and requiring but one-half the number of magnets as a radial multipolar machine of same number of poles.

Fig. 97 shows a field frame of the multipolar iron-clad type, having six poles, which is the form employed in the gearless street car motor of the Short Electric Railway Company, Cleveland, O. In Figs. 98 and 99 two special cases of this type are depicted, both representing four-polar iron-clad types, and differing only in the position of the magnets. The horizontal four-polar iron-clad type, Fig. 98, is used in the Edison iron-clad motor (General Electric Company) and in the dynamos of the Wenstrom Electric Company, Baltimore, Md. The vertical four-polar iron-clad type, Fig. 99, is employed by the Elliott-Lincoln Electric Company, Cleveland, O.

Fig. 100 shows a special case of the horizontal four-polar iron-clad type, obtained by symmetrically doubling the frame illustrated in Fig. 84, and providing four poles instead of two. The cores are so wound that the centre of the cylindrical iron wrappage has one polarity and the ends the opposite polarity. Two oppositely situated pole-pieces

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are joined to the middle, and the two sets of intermediate ones to the ends of the magnet frame; the lower half of Fig. 100 consequently is a section taken at right angles to the upper half, the diametrically opposite sections being identical. This type has been developed by the Storey Motor and Tool Company, New York.

Multipolar fields may also be formed by a number of independent horseshoes arranged symmetrically around the outer armature periphery. Figs. 101 and 102 show two such multiple-horseshoe types, double-magnet horseshoes being employed in the former and single-magnet horseshoes in the latter type. Multiple-horseshoe machines of the double-magnet form, Fig. 101, have been designed by Elphinstone and Vincent, and by Elwell-Parker Electric Construction Corporation, England, while the single-magnet form, Fig. 102, is employed by the Electron Manufacturing Company (Perret), Springfield, Mass.

Further forms of multipolar fields can be derived from the bipolar horizontal and vertical double-magnet types respectively. If in the vertical double-magnet type, Fig. 76, an additional pole-piece is provided at the centre of the frame so as to face the internal surface of the armature at right angles to the outer pole-pieces, the four-polar vertical double-magnet type is created, which when laid on its side will constitute the four-polar horizontal double-magnet type, Fig. 103. If in the vertical double-magnet type, Fig. 78, the two cores are cut in halves and additional pole-pieces inserted at right angles to the existing ones, the vertical quadruple-magnet type, Fig. 104, is obtained; the same operation performed with the horizontal double-magnet type (77) will give the horizontal quadruple-magnet type.

Four-polar horizontal double-magnet dynamos are, Fig. 103, built by the Zurich Telephone Company, Zurich, Switzerland; and vertical quadruple-magnet machine, Fig. 101, by the Duplex Electric Company, Corry, Pa.

Numerous other multipolar types have been invented and patented, but have not yet come into practical use.

Selection of Type.—If the type is not specified, the field-magnet frame for a large-output machine should be chosen of one of the multipolar types, as in these the advantage of a better proportioning and a higher efficiency of the armature winding, and the possibility of a symmetrical arrangement of the magnetic frame, results in a saving of copper as well as of iron; while for smaller machines—below 10 kilowatts capacity—the bipolar forms are preferable on account of the great complication caused by the increased number of armature sections, commutator divisions, field coils, etc., necessary in multipolar machines, and on account of the narrowness of the neutral or non-sparking space on a multipolar commutator.

The field, moreover, should have as few separate magnetic circuits as possible; thus in the case of a bipolar type, it should be a single magnetic circuit rather than the consequent-pole type which is formed by two or more magnetic circuits, of one or two magnets each, in parallel, because the former is more economical in wire and in current required for excitation. In two-circuit consequent-pole machines, for instance, such as the double-magnet types, Figs. 77, 79, and 80, and the double-horseshoe types, Figs. 81 and 82, according to Table LIII., Chapter 43, there is 1·41 times the length of wire, and consequently also 1·41 times the energy of magnetisation, required than in a single circuit, round cores being used in both case, and the single circuit having exactly twice the area as each of the two parallel circuits in the consequent-pole machines. Triple and quadruple magnetic-circuits—*i.e.*, three or four cores, or sets of cores, magnetically in parallel—are still more objectionable, requiring, when the cores are of circular cross-section, 1·73 and 2·00 times as much wire respectively as a single magnetic circuit having a round core of equal total sectional area.

If a machine has several magnetic circuits, each of which, however, passes through all the magnets in series, then the frame is to be considered as consisting of but one single circuit, for the subdivision only takes place in the yokes, and it is immaterial as to the length of exciting wire whether the return path of a single circuit is formed by one yoke or by a number of yokes magnetically in parallel. The above-named objection to divided-circuit types consequently does not apply in the case of the iron-clad forms, Figs. 83 to 87.

According to Table LII., Chapter 40, the horizontal double-magnet type, Fig. 75, and the horizontal iron-clad type, Fig. 83, are the best bipolar forms, magnetically. The iron-clad types, furthermore, possess the mechanical advantage of having the field windings and the armature protected from external injuries by the frame of the machines, which makes them eminently adaptable to motors for railway, mining, and similar work.

The inverted horseshoe type, Fig. 68, which ranks very highly as far as its magnetic qualities are concerned, has the centre of its armature at a comparatively very great distance from the base, requiring very high pillow-blocks, which have to carry the weight as well as the downward thrust of the armature inherent to the inverted forms having the field windings below the centre of revolution (see Chapter 24). The side pull of the belt with a high centre line of shaft tends to tip the machine, and the changes in the pull due even to the undulations of the belt will cause a tremor in the frame, which jars the brushes and eventually loosens their holders, and which has a disastrous influence upon the wearing of the commutator. On this account the inverted forms, or "under-types," can only be used for small and medium sized machines, in which the height of the pillow-blocks remains within practical limits.

In selecting a multipolar type, Table LII. shows that the radial inner-pole type, Fig. 89, offers the best advantage with regard to the magnetical disposition; with this type, however, are connected some mechanical difficulties, due to the necessity of supporting the frame from one of its ends, laterally, and the armature from the other.

In the outer-pole types the armature core can be supported centrally from the inner circumference, and the frame suitably provided with external lugs or flanges resting upon the foundation, a most desirable arrangement for mechanical strength and convenience. The most favourite of the outer-pole forms is the radial outer-pole type, Fig. 88, on account of its superiority, magnetically, over the tangential and axial multipolar types.

In all dynamo designs the consideration is especially to be borne in mind that the whole machine, as well as its various parts, should be easily accessible for inspection, and so arranged that they can conveniently be removed for repair or exchange. A large number of machines owe their popularity chiefly to their good disposition in this respect.

The shape of the frame in all cases is preferably to be so chosen that the length of the magnetic circuit in the same is as short as possible.

(To be continued.)

LEEDS TRAMWAYS.

In the report presented to the Tramways Committee of the Leeds City Council, the city engineer (Mr. Hewson) states that he is in favour of a quicker service of cars than obtains at present. He thinks it should not be less than one of 7½ minutes, with short routes across the city, and consequent overlappings of 3¾ and 1⅞ minutes' service in the centre. On this basis, Mr. Hewson makes a comparison of cost between the present system of haulage, the cable, and the electric system. He takes first the capital, and secondly the annual sum each would require, remarking, however, that his estimates do not include the use of the spare heat at the refuse destructors, his reason for this being that, even supposing the whole cost of fuel could be saved by utilising this heat, the saving would be less than the gain from having the overhead electric generating system at one central station, or the cable system at a minimum number of stations, all being placed in the best situation for coal, water, and economical working. With respect to the present system, he finds that the total first cost, and the cost of remodelling the existing tramways, including buildings and improved equipment up to 7½ minutes' service, would be £265,884. As to the cable, his estimate

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is £428,922. For the overhead electric system, the estimate is £378,499.

With regard to the annual cost of working these three systems, the figures are based on the service suggested—viz., 7½ minutes in the outskirts and 3¾ and 1⅞ minutes in the centre of the city. The total annual cost of the present system he puts down at £117,292; of the cable at £101,819; and of the overhead electric system at £90,072. Thus we have:

	Estimated capital account.	Estimated annual cost.
Present system	£265,884	£117,292
Electric system	378,499	90,072
Cable system	428,922	101,819

The difference in favour of the overhead electric system over the cable system is therefore £50,423 in capital account and £11,747 in annual cost. As the number of cars and service in each of the systems would be alike, the income on each of the systems would be exactly the same.

In conclusion, Mr. Hewson remarks that whilst it is true that the cable cars with a certain frequency of service beat the electric overhead in point of cost, excepting in towns having more severe gradients and a longer length of them than there are in Leeds, this feature has been greatly exaggerated. He finds that the frequency required must be less than a 1⅞ minutes' service; but it should be remembered (to be complete in this respect) that that service must extend over the whole tramway system, or the cable system of the city fails. Such a service is out of the question. For instance, supposing Briggate and North-street, Boar-lane, Wellington-street, and Woodhouse-lane to Hyde Park-corner were on such a service as would give the advantage to the cable—say a one-minute service—the cable system for the whole undertaking of Leeds would then have only 6½ miles of paying line to meet the loss of 28½ miles in the remaining—*i.e.*, the slower part of the system. It has been suggested to Mr. Hewson—and until going into figures he thought such an arrangement might be feasible—that the centre of the city should be worked by cable system and the outskirts by electricity, but from the figures he has already given it will be seen that the cable system with its necessarily quick service and the traffic needful to warrant such a service would be so limited in length as to render such a suggestion not practicable. Comparing the advantages of the two systems, even ignoring finance, it appears, putting it broadly, that if it were not for the objectionable appearance which the poles and wires of the electric overhead system lends to the streets and the weight of the car, that system would be practically in all respects superior to the cable. In regard to the weight of the car, it is only 6¼ tons, and not 9½ tons, as is generally stated, and the weight of those now being made is only five tons, whilst the weight of the present bogie cars drawn by steam-engines is 4½ tons, thus leaving little to be complained of in this respect. As to the poles and wires, a great improvement can be made in regard to them also. All the wires running along the footpath should be laid underground, and all the poles placed against the buildings, or when the width of the streets will permit, ornamental posts carrying arc lights should be placed in their stead in the centre of the roadway. With these improvements, and remembering that electric traction has a wider field for improvement than cable, he is of opinion that the overhead electric system of haulage is certainly the cheapest and the best system for the city of Leeds.

THE RECENT GAS EXPLOSIONS IN ST. PANCRAS.

ANOTHER EXPLANATION OF THE CAUSE.

The following is a copy of a letter addressed by Sir Courtenay Boyle, on the 28th ult., to the chairman of the Electric Lighting Committee of St. Pancras Vestry:

Adverting to the interview which you were good enough to give me yesterday, and to the conversation which we had on the subject, I am directed by the Board of Trade to state, for the information of the Electric Lighting Committee of the St. Pancras Vestry, that Major Cardew, the electrical adviser of this department, has discovered in his investigations into the recent explosions in the street boxes used for electrical supply in St. Pancras, that a remarkable deposit on some of the insulators contained a considerable quantity of the metal sodium.

The presence of this metal, which is highly inflammable by contact with water, appears to be so grave a source of danger, and to afford so reasonable an explanation, in connection with the accumulation of escaped coal gas, of the several explosions which have recently occurred, that it devolves upon the Board of Trade without any delay whatever to investigate the causes of the deposit of this substance with a view to its prevention, and in this investigation they have asked for the assistance of the Royal Society and of the Institution of Electrical Engineers.

In the meantime, in order to prevent as far as possible the recurrence of similar explosions, the Board of Trade would strongly urge that the Vestry, through their Electrical Committee, should immediately—

(1) Provide a thorough system of ventilation for their conduits and street boxes.

(2) Reduce as far as possible the space in their street boxes within which an accumulation of gas can occur.

(3) Make a thorough inspection of their mains and remove the above-mentioned deposit wherever it is found to exist.

As regards the means to be taken for prevention of the recurrence of such deposit, the Board of Trade hope to be able to communicate with you further without delay.

Mr. A. E. Pycraft, of the Electricity and Public Lighting Department of the St. Pancras Vestry, sent the following reply to Sir Courtenay Boyle on the 1st inst.:

A special meeting of the Electricity Committee was held last evening, when the chairman reported the conference held at your offices on Wednesday last on the subject of the recent explosions, and your letter of the 28th ult. was considered. I was instructed to inform you that the committee desire to record appreciation of the courtesy shown by you in the desire to assist the Vestry, and are thoroughly in accord with the Board of Trade in their desire to prevent a recurrence of the explosions that have recently taken place.

With regard to the several recommendations contained in your letter, the committee have instructed their engineer to have fixed without delay ventilating pipes for getting rid of any accumulation of gas in the manholes and culverts, and pending further consideration respecting reducing the size of the manholes to fill them up as far as practicable with bricks. Extra men have also been engaged inspecting the mains and removing whatever deposit may be found on them. The committee note the Board of Trade have asked the Royal Society and Institution of Electrical Engineers to investigate into the causes of the deposit of the metal sodium, and that the Board will inform the Vestry the result of such investigation.

The committee also expressed a hope that the Board of Trade would bring pressure to bear on the gas company to remedy the defective state of gas mains and services in this district, and thus remove the primary cause of the explosions.

ELECTRIC HEATING OF THEATRES.

In a previous issue we referred to the recent introduction in the Vaudeville Theatre, at very short notice, of electric heating appliances, which have given satisfaction both to the lessee and to theatre-goers. The introduction of electric heating in this theatre should be of interest to the electrical profession, as marking an era in the use of electricity for warming purposes. The fact that heat produced by electricity at the present rates is more expensive than by other systems would seem to prohibit its use in large buildings, but it does not follow that the cost per unit of heat being higher the total cost of heating for a certain period will also be higher. The time of heating required is necessarily an important point in considering this matter, and with a theatre this is only a short period, say, three or four hours out of the 24. If therefore a system of heating can be employed for four hours in place of a method which requires eight hours from start to finish, it is evident that the former will be as cheap in the end as the latter, even though it may cost twice as much per unit of heat produced. It is customary during the winter, with steam or hot-water systems, to keep the fires in day and night in order to provide sufficient warmth for the hours of performance. With electric heating, however, it is only necessary to turn on the current a comparatively short period before the performance takes place. Again, most systems hitherto adopted require constant attention, and a suitable spot must be found in which to place the heating furnace and flues with safety. This part of the heating arrangement is carefully supervised by the fire insurance offices and the local authorities, and in crowded parts, where theatres are mostly situated, it is not always an easy matter to find a suitable place for these dangerous elements. Many theatres are unprovided with warming arrangements, as the gas formerly used for lighting produced more heat than was

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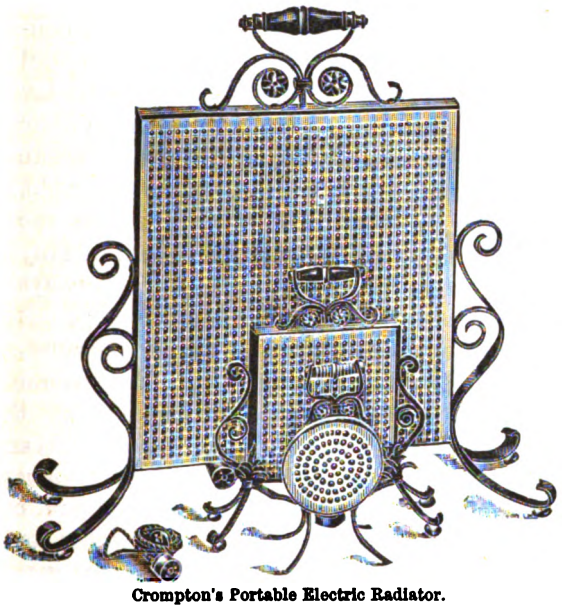
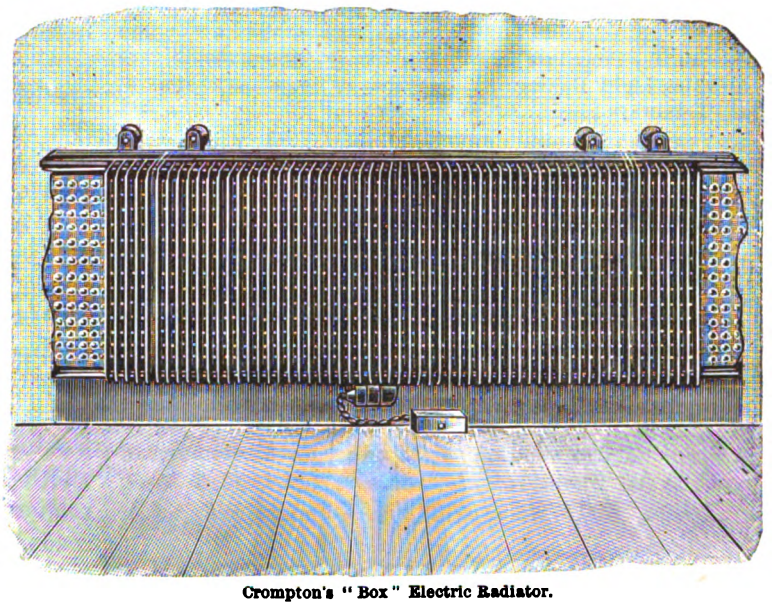
actually required. Since, however, the electric light has been introduced it is necessary to provide some system of warming, and fortunately the same agent which produces light is now available for producing a welcome degree of warmth. The use of the electric light has purified the air of the theatre and made the "theatre headache" a thing of the past, and the electric radiators now coming into use will in no way contaminate the air or offer any other objectionable feature. Small electric radiators have been in use in houses for some two years past, and their use is growing rapidly, but most engineers have hitherto discouraged any attempt to use electricity for heating on a large scale.

The authorities at the Vaudeville found it necessary to provide some system of warming, and, after considering the usual methods, they came to the conclusion that electricity offered advantages over all others. A trial was made with four large radiators of the "Crompton-Dowsing" type, taking 12 amperes, with a total of 36 square feet of heating surface. These radiators were connected with the lighting circuit, and placed in the best positions for warming the most important parts of the theatre. A week's trial showed excellent results, and it was evident that with more heating surface sufficient heat could be obtained for all requirements. An order was, therefore, placed with Messrs. Crompton and Co., Limited, of 148, Brompton-road, S.W., for the supply of electric radiators, to be fixed around the skirtings on either side and along the front of the orchestra. These radiators are of "box" form—that is to say, the plates have a front radiating surface studded with projections fixed in cast-iron cases, which are screwed by means of lugs and insulators to the walls and partition. Each box radiator is 2ft. long and 1ft. wide, and therefore offers a radiating surface of two square feet. The air is allowed to circulate between the case and the wall, so that an extra heating surface is obtained. There are six box radiators on either side and 12 attached to the partition in front of the orchestra. The latter are cased in at the back, and a good current of air is obtained by carrying the casing below the boxes containing the radiators.



Crompton's Portable Electric Radiator.



Crompton's "Box" Electric Radiator.

The four large portable radiators originally supplied on trial are arranged for use either in the stalls or at the sides. Four wall sockets are fixed on each side and four on the chair supports in the centre of the stalls. By means of these connectors, the radiators may be employed to warm the centre before the performance begins, and afterwards removed to the sides. Each radiator, portable and fixed, has a safety connector, and can be detached from the circuit at will. The radiators reach the usual temperature of hot-water pipes, and they are found to produce quite sufficient heat. The average temperature of the theatre inside after the radiators have been working a reasonable time is about 60deg.—*i.e.*, temperate—when the corridors are about 40deg. Most theatres are subject to draughts from the frequent opening of doors and from the stage, but notwithstanding these, the temperature of the Vaudeville Theatre is maintained fairly constant. Arrangements are now being made to warm the stage, and no doubt this will prevent the passage of the cold currents of air usually experienced when the curtain is raised.

The current taken by each large portable radiator is 12 amperes, and the small box radiators take three amperes each, making in all a total of 114 amperes, but as only two of the large radiators are found necessary, the current actually used for warming the auditorium is 90 amperes at 100 volts. Thus it will be seen that nine units per hour are required when the whole apparatus is in full work, and the cost—at 4d. per unit—is 3s. per hour. To warm the theatre, therefore, for a period of four hours, the cost would be 12s., and it is believed that a suitable hot-water system (particularly where gas is employed, as proposed for the Vaudeville), including attention, loss of heat in transmission, and in other ways, would cost as much. Moreover, there is the danger of a red-hot furnace in close proximity to the stage, but this is obviated by the use of electricity. Another distinct advantage makes electric heating far preferable to other systems, and that is, the perfect regulation. Thus, the whole or any number of the electric radiators may be put on or cut off at will, and there is no fear of overheating the theatre and making it uncomfortable at any time. No attention whatever is required with the electric radiators, and any of the theatre attendants can turn the current on or off according to the requirements of the case. Owing to the fact that the radiators have not to be turned on until a short time before the performance begins, the state of the weather may be judged and the heat graduated accordingly. In comparing the up-keep of the electrical plant with hot-water systems, Messrs. Crompton and Co. state that the former will in all probability be considerably less than the latter, owing to the fact that there is no furnace to burn out and no rusting or wearing out during long periods of disuse. Electric radiators are found to be very durable, they are not required to reach high temperatures, and they offer a large radiating surface. With other heating and cooking arrangements, where a far higher temperature is required, damage is often caused by leaving the apparatus connected after the cooking operation has been completed. This allows of an accumulation of heat in the electric heater which may cause it to fail altogether. The electric radiators, however, are so constructed that they cannot overheat themselves; they radiate the heat as freely as it is produced, and, as a consequence, may be left to work without attention and in perfect safety.

The installation at the Vaudeville has been carried out with the greatest care; Henley's cables, of high insulation, are used, and the switches, cut-outs, safety connectors, etc., are of the latest and best type. This being a pioneer installation, some difficulties were at first experienced with regard to the insurance rules, none of which were applicable to the special circumstances of the case. Mr. Musgrave Heaphy, of the Phœnix Fire Office, who had to pass the work, has now drafted out a set of rules with regard to electric heating which will be applicable to all work of the kind in future. The cost of installing the electric heating apparatus at the Vaudeville has been found to be about the same as for hot-water heating, and, taking all into consideration, the electric system of heating offers many advantages over the older forms of heating employed which would justify even a higher price.

It may be stated that electric radiators are on trial at several other theatres and public buildings, and in many places where other systems of heating are in use it is proposed to employ these radiators for temporary assistance in extra cold weather, or for use at a moment's notice when no provision has been made for warming the whole of a building in the usual manner. Cold corners and other places may now be warmed where other systems of heating were entirely barred on account of the danger in their use. It is proposed to use electric heating in churches, and electric foot-warmers have been suggested. The latter were to be used at the Vaudeville Theatre, but the time required for supplying and fixing them would take too long. Altogether there appears to be a field for the use of electricity for heating purposes, and it rests with the supply companies to make their charges as low as possible in order to induce business in this direction.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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LIGHT RAILWAYS.

The subject of light railways has now been brought very prominently before the public, and although we do not think that such railways would immediately be hailed as a panacea by the agricultural classes, there can be little doubt that continental competition for the supply of produce to the London market is immensely facilitated by the presence of such means of cheap transport in Belgium, France, and Denmark. The papers recently read by Mr. A. C. Pain before the Surveyors' Institution, by Mr. Meik before the International Railway Congress in London, and by Messrs. W. W. Beaumont and Stephen Sellon before the Society of Engineers, all point to the great interest shown in the subject by engineers. There can be no doubt, if capitalists can be induced to support one or two projects for light railways in properly selected districts, that a wide field will be opened up for further development. Personally, we have very strong ideas upon the subject, and we feel sure that if the present stringent regulations dealing with railway traffic are not very much relaxed, nothing of importance will result from the present agitation. Before all things, the proposed lines must be constructed cheaply, and, judging from continental practice, it will be found far the best plan to lay the lines along the sides of the ordinary public roads. In many parts of the country the waste land alongside the road is four or five yards wide, and where such a width cannot be obtained the roadway itself might be encroached upon. Many persons seem to consider that these light railways should be constructed upon the ordinary gauge, but we believe that this is a very great error, because, firstly, the rolling-stock used on such lines would never be allowed to travel upon main lines, as it would not be well enough built; and, secondly, the width required to allow for passing places would render it quite impossible to use the sides of public roads. Rolling-stock of ordinary gauge would be also far too heavy to be handled with ease by manual labour, and, in our opinion, that requirement is an essential for success.

We cannot look with favour upon the various projects which have been brought before the public whereby it is thought the advantages of the ordinary and narrow gauges can be both combined. We refer to the construction of loose bodies of trucks which can be put upon bogies of ordinary gauge on the main lines, and on narrow-gauge bogies on the light railways: all such bodies are far too heavy, and would necessitate a very strong permanent way. The ideal line is, in our opinion, of the type first brought out by Decauville, in France, and now made by many firms in this country: a gauge of about two feet, with the line laid permanently alongside the road, and having what we may term flexible ends to go right into the fields, brickyards, or other places whence goods are to be transported. The farmer must be able to take the trucks into his fields and load them there, then run them through his farmyard either by manual labour or horse power, and then the same trucks must be taken along the light railway to the station on the main line.

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If a light railway is to be made in such a way that it cannot enter the farmyard, the farmer will be obliged to load his produce into carts as he does at present, and once in a cart he may as well avoid transhipment by carting it to the station of the main line. The portable portions of the track in the fields and the wagons could either be let on hire to the farmer by the light railway company, or he might be supplied gratis with the wagons and be required to purchase the portable portion of the track. The chief point, however, is to put the farmer himself to as little expense as possible. He is now stated to be in the last stage of poverty, and it is impracticable to burden him further. The lines should be worked by the overhead wire system of electricity, the wires being carried upon side brackets standing out from posts in the hedgerows. The potential used would be, say, five hundred volts, and if such light railways radiated from the main-line station the service of trains upon them might be so arranged that the maximum output from the generating plant would not be greatly in excess of that required for, say, a single train. The speed required would not exceed eight to ten miles per hour, and passengers could be carried on the well-known jaunting-car system. No system of storage of electricity is yet sufficiently cheap to be of service, either in the trains or in the generating station.

The crux of the whole question is, however, the obtainment of capital to carry out the projects. Nothing will be done if it is necessary to apply to Parliament for powers for each separate scheme, as the system is far too expensive and leads to enormous over-capitalisation. We believe that the only practicable method is to offer a guarantee out of the rates, and call upon the public for a portion only of the capital required. The Board of Trade might well be made the final authority before which evidence would be given, and the county or district councils would be the bodies directly in touch with the promoters. All appeals would then be heard by officials of the Board of Trade. If this method were carried out, and powers for construction could be cheaply obtained, such light railways might be expected to pay from 3 to 4 per cent. dividends. As traffic increased it would be possible to improve the lines, but at present the cheapest possible system is, we are firmly convinced, the only one which can be profitably employed.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TESTING INSTRUMENTS.

SIR,—We notice a letter in your issue of 1st inst., under the above heading, evidently referring to our catalogue, which you lately noticed. Our attention is particularly directed towards the last sentence of this letter as to copying original designs of other makers.

Mr. Paul has apparently forgotten the old saying advising people what not to do when living in glass houses. We have before us a list of his manufactures (List No. 5) in which we find but three illustrations besides those of the galvanometer he refers to. Two of these (Nos. 5 and 6) are practically copies of our original designs, and will be found in our catalogue of a quarter of a century ago; whilst the third (No. 4) bears a wonderful family likeness to an illustration given in a catalogue published many years ago by M. Carpentier, of Paris. For our own part we make no objection, believing imitation to be the sincerest form of flattery.—Yours, etc.,

London, March 6, 1895. ELLIOTT BROS.

REVIEWS.

Dynamo Construction: A Practical Handbook for the use of Engineer-Constructors and Electricians-in-Charge By JOHN W. URQUHART. Price 7s. 6d. Second edition, revised and enlarged. Crosby Lockwood and Son.

That this work has passed through a first edition and that a second has been called for shows that, whatever opinion a critic may hold, there is a demand for a simple descriptive book on the subject. The best friends of Mr. Urquhart cannot accuse him of originality, but they may claim that he is an energetic seeker amongst current literature for that which will assist him in compiling books. Such compilations have considerable value, for in these busy times it is almost impossible for everyone to find time to make himself acquainted with the various improvements in all directions which have taken place in dynamo work. Very broadly speaking, there are two classes of technical books—one descriptive of what has been done, the second dealing with principles to show how it is and why it is done. Both have their uses. This book is of the first kind, and of its kind is good.

PARLIAMENTARY PROCEDURE AS AFFECTING LIGHT RAILWAYS AND TRAMWAYS.

The members of the Society of Engineers, at a meeting held at the Westminster Palace Hotel on Monday, Mr. Wm. George Peirce, president, in the chair, listened to a paper by Messrs. W. Worby Beaumont, M.I.C.E., and Stephen Sellon, A.M.I.C.E., on "Parliamentary Procedure as Affecting Light Railways and Tramways."

In the first part of this paper the authors referred to the stagnation which has for years characterised the light railways, tramroads, and tramways construction branches of engineering. This they consider is chiefly due to the heavy capital burden with which most projects are loaded, capital which is not required either for the construction of working of the lines, and which, moreover, is never available for either of these purposes. The costs of obtaining permission to construct a line, even where called for by the inhabitants of the districts to be served, are at present excessive, as a result of the procedure according to which a scheme is not examined as to its merits by any responsible body or department before all the costly machinery necessary for meeting opposition from any source is put in motion. This introduces the speculative element into the first stages of the promotion of a scheme, inasmuch as considerable sums of money have to be provided to put and keep this legal and other machinery in motion and to buy off opposition. This money has to be provided before it is known that the scheme will receive or is likely to receive assent, and hence the money provided for these purposes is only advanced on extremely heavy terms. The authors referred to these questions and to the heavy expenses incurred to meet the Board of Trade rules, the rules as to standing orders and others framed under statutes.

As an example of the necessity for more freedom in the exercise of discretion with regard to mechanical and minor matters affecting tramroads, it may be mentioned that whilst every Tramway Act permitting the use of mechanical traction requires all steam locomotives to be fitted with automatic speed governors and brakes, a requirement which the Board of Trade officers are bound therefore to enforce, no such requirement is demanded by them with regard to electrical tramcars. They do not feel bound to enforce it because electric locomotives are not steam locomotives. Part of the South Staffordshire tramways is worked by 17 electric motor cars, weighing six tons each, where formerly it was worked by steam locomotives. On this piece of line no such automatic governors and connected brakes have ever been found necessary, neither have they at Leeds or Blackpool. Clauses such as these inserted in Tramway Acts hamper the engineer in the proper working of a line, and the Board of Trade official becomes a mere clerk of works following a specification, whereas he should be free to insist on

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or to relax provisions with regard to mechanical details according to circumstances and to the requirements of the case as affected by progress in construction, and by the demands of a district or by the kind of traffic.

The authors propose various relaxations in the Board of Trade rules, and propose that with regard to any *bonâ fide* schemes the proposition and proof of public utility should be heard first somewhat after the manner of a Local Government enquiry, and that opposition should be heard afterwards if the proposed preliminary enquiry gives encouragement to proceed. According to present arrangements, the Standing Orders Committees give assent in response to a prayer that the scheme be allowed on the grounds of its public advantage, and yet the public advantage thus admitted and the admission of the good grounds of the prayer may count for nothing in the face of opposition of one man or one Board of Trade rule, which may be founded on obsolete or antiquated statutory requirements.

The authors propose that agreements entered into before date of standing orders should come before the committee, so that unreasonable sums should not be added to the necessary capital by way of bought-off opposition or excessive promises to pay for accommodation by speculative advances which may ruin the prospects of a scheme from the first and make high rates and fares necessary. The authors also propose that instead of two separate committees, one of each House, there should be a joint committee so that the expense should be that of one enquiry instead of two, but they propose that the decisions may be either joint or independent as may in each case seem needful. The authors also propose that no clauses should be inserted in a Bill at the instigation of opposing parties without investigation by the committee, and also that the relation between the proposed capital and reasonable cost of construction and equipment should be considered by the committee, as restricted debentures provide no protection against over-capitalisation. Numerous other modifications are referred to as necessary to secure facilities for the construction and working of tramroads and tramways which shall place them on a footing comparable with that which obtains in France, Belgium, and elsewhere.

The authors consider that light railways are required in some districts, but that there is a greater field for the profitable construction and working of tramroads and tramways if the proposed modifications in procedure and the proposed relaxations in rules are made. The paper concludes with reference to the recent Board of Trade Committee on Light Railways and reproduces some of the proposals made by several members of the committee who disagreed with the general report as insufficient, and at offering very little aid towards a settlement of the questions raised by the Board of Trade reference or towards definite proposals on the questions raised by the President of that Board.

ELECTRIC TRANSMISSION OF POWER.

BY ALEXANDER SIEMENS.

Some three months ago a paper was read by Mr. Alexander Siemens on "Electric Transmission of Power" before the North of England Institute of Mining and Mechanical Engineers. This paper, of which the following is an extract, is published in the *Transactions* of the Federated Institution of Mining Engineers:

The writer's principal object is to lay before the members some results of the adoption of the electric transmission of power at the Woolwich works of Messrs. Siemens Bros. and Co., where the change was commenced about two years ago, and is even now not quite completed. The diagram, Fig. 1, shows a plan of the works, which cover about six acres of ground.

At the central station, 12A, there are five boilers working at a pressure of 130lb. per square inch of the "gunboat" type—*i.e.*, two-flued multitubular boilers, each 18ft. long and 9ft. in diameter. They are hand-stoked, and supply steam to the machinery of the central station, to the steam-engines driving the guttapercha shop, and for heating purposes. Condensers are placed on the roof of the boiler-house, each sufficient for 25 i.h.p. These condensers consist of two cylinders, one placed

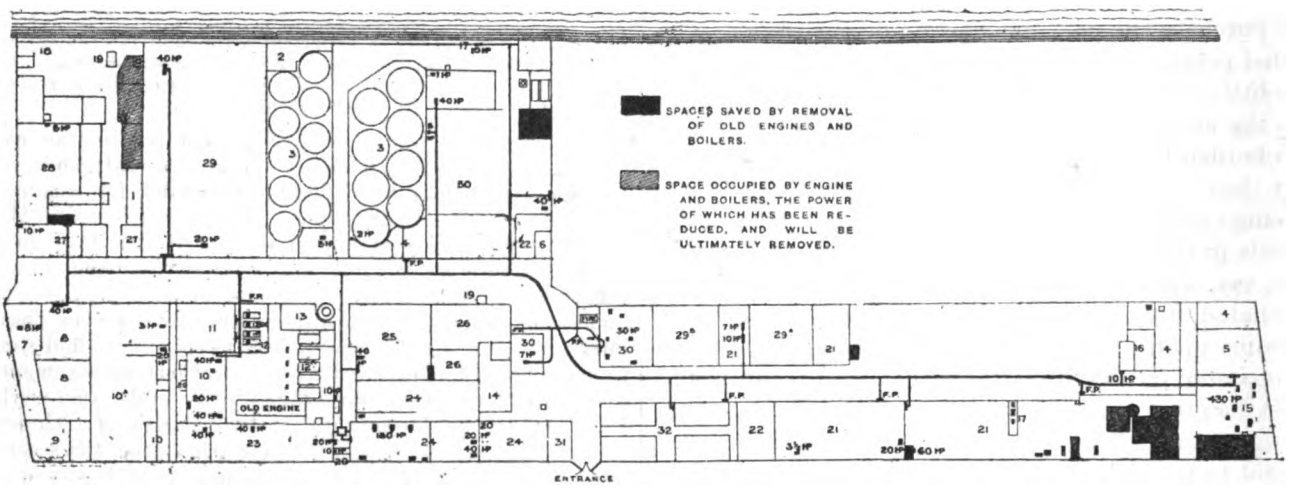
SPACES SAVED BY REMOVAL OF OLD ENGINES AND BOILERS.
SPACE OCCUPIED BY ENGINE AND BOILERS, THE POWER OF WHICH HAS BEEN REDUCED, AND WILL BE ULTIMATELY REMOVED.
OLD ENGINE
ENTRANCE

FIG. 1.

inside the other, forming an annular space into which the steam passes from the engines while cold water is trickling down the outside of the larger and the inside of the smaller cylinder. The condensing water is used to feed the boilers and to supply the guttapercha and indiarubber washing-tanks, and the condensed steam is allowed to run to waste. In the engine-room, 12, which measures 42ft. by 30ft., there are four steam dynamos, each capable of giving a current of 1,500 amperes at 120 volts pressure when running at 350 revolutions per minute. All four dynamos are exactly alike, being two-polar drum armature machines of the Siemens H.B. $^{24}/_{36}$ type, shunt wound, and

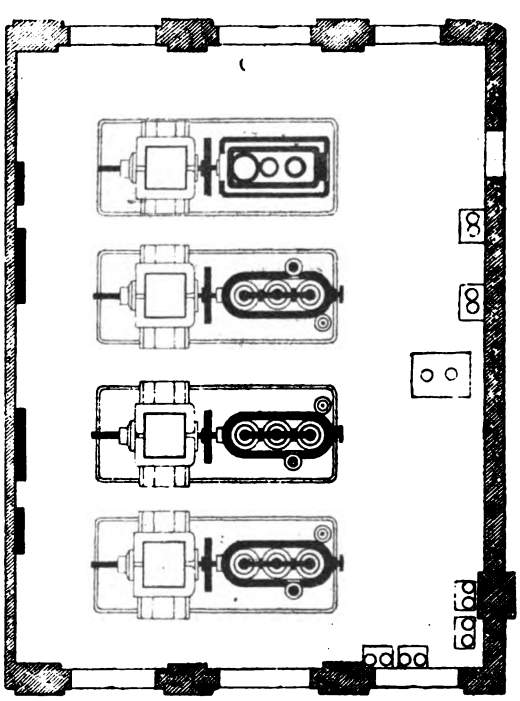

FIG. 2.

fitted with switch and resistances for varying the exciting current by hand. Three of the dynamos are driven by three Willans III compound condensing single-acting engines, and the fourth is coupled to a Belliss compound condensing double-acting engine, Fig. 2.

The four generating sets are coupled in parallel to an omnibus bar, with ampere indicators showing how much current each set is giving, and from this bar the main cables are laid to the various departments, a safety fuse and an indicator being fitted in each circuit. Provision is also made on the switch-

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board for coupling two of the generating sets in series, when a current of 240 volts pressure is required at any part of the works, Fig. 3. The return cables are also all joined to one bar, and from this bar the current passes through a registering meter before it returns to the dynamos, Fig. 4. In this way an exact record is kept of the current generated at the central station. The total length of cable laid between the switchboard in the engine-room and the distributing-boards in the various departments is a little over 18,000ft., the area of the cross-section of the copper conductor varying from ¼ to 1½ square inches. Each department has its distributing-board, to which the current is brought from the central station by one or more main cables; it is fitted with a registering meter, and with fuses for the branch cables which lead to the various motors in the department, Fig. 5. All the main cables have the copper conductor insulated by impregnated jute, covered with lead, which in its turn is protected by tarred jute and steel ribbon, again covered with jute and compound. These cables are laid directly into the ground without farther protection, and have never given any trouble. Owing to the rules of the London County Council, each motor is completely enclosed, and by no means readily accessible. Some motors are quite closed in with sheet iron, so that nobody may come in contact with moving parts.

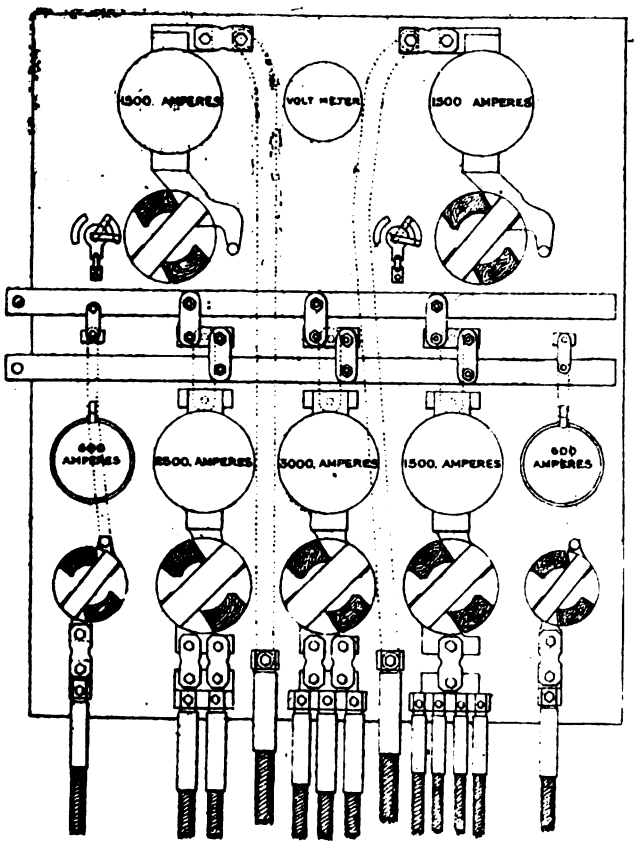

FIG. 3.

In other instances an iron framing covered with iron netting is put round the motor, and this arrangement has the advantage of permitting a free circulation of air. At the present time 72 motors are in use, varying in size from 100 b.h.p. to ⅛ b.h.p, and capable of giving a total of 1,407½ b.h.p.

The output of the central station is 1,200 i.h.p., which with an efficiency of 86 per cent. gives 1,130 e.h.p. available at the central station, or, roughly, 1,000 b.h.p. at the moters in the workshops. With regard to these figures, it should be remembered that the whole plant is capable of producing from 25 to 30 per cent. more output, when required for a few hours, without any danger of straining any part of it, and this is the safeguard to which the author has already called attention, and which ensures the satisfactory working of such an installation. Before the electric transmission was introduced, 18 steam-engines were employed, capable of yielding altogether 1,446 i.h.p. These correspond to about 1,150 b.h.p. then available for driving machinery. Seven of the old steam-engines, giving about 380 b.h.p., are still in use, so that the total power now at disposal for motive purposes is 1,787 b.h.p., while, in addition, the central station furnishes current for 72 arc lights and about 1,600 16-c.p. incandescent lights.

A comparison of these figures will at once show that the works have been considerably extended since the first steam dynamo was started, on June 20, 1892, and for this reason it has been rather difficult to find out how the cost of power at the present time compares with that of working steam-engines alone. Another circumstance which made such an enquiry complicated was that the work on a large cable contract this year increased all expenses of fuel and labour to such an extent, that the preceding years cannot be compared with it in order to determine the exact saving that has been effected. In former years, cable work of equal duration increased our consumption of

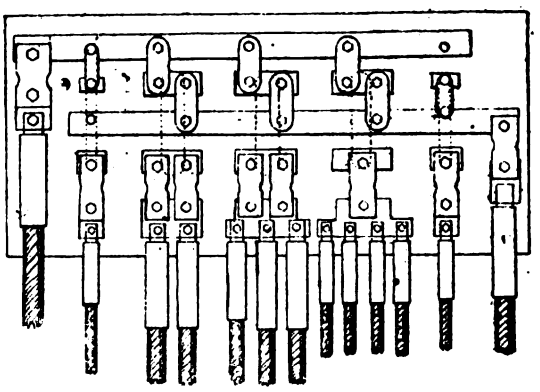

FIG. 4.

coal by nearly 5,000 tons, but this year the increase has not been more than about 2,000 tons, so that an actual saving appears to have been effected of about 3,000 tons of coal. The steam-engines and boilers of the old installation were tended by 10 stokers and nine engine-drivers, while at the present time eight stokers are employed, of whom three attend to the old boilers still in use, and five engine-drivers, three of whom attend to the old engines. The electrical part of the machinery in the central station is attended to by one electrician and a boy, while the motors are attended to by the oilers of the various departments. When the arrangements are completed, all auxiliary boilers will be abolished, and a farther saving of attendants will be effected.

As far as they go, these comparisons prove that the electric transmission has been economical, but in order to obtain satisfactory information as to the performance of the plant a series of tests were conducted by the experiment department, under the direction of Dr. Eugin Obach, as follows: The boiler tests and engine tests were carried out separately in two series. The first series was intended to determine the weight of steam generated per pound of fuel, and this test extended over a month of ordinary working, and included all necessary coal for lighting up. The second series was intended to determine the weight of steam required by the engines per Board of Trade unit delivered to the distributing bars of the central-station switchboard. This was found by exhausting the engine under test into the main condenser and measuring the overflow from the air-pump, taking care that no other water could mix with the overflow. These engine tests were subdivided again into two kinds: (1) running on steady artificial loads of about a quarter, half, three-quarters, and full load; and (2) running on the ordinary day load. The second set of tests was undertaken to see if a varying day load required the same weight of steam per Board of Trade unit as a perfectly steady load giving the same output. This was found to be the case: the point obtained by the day-load test fell exactly on

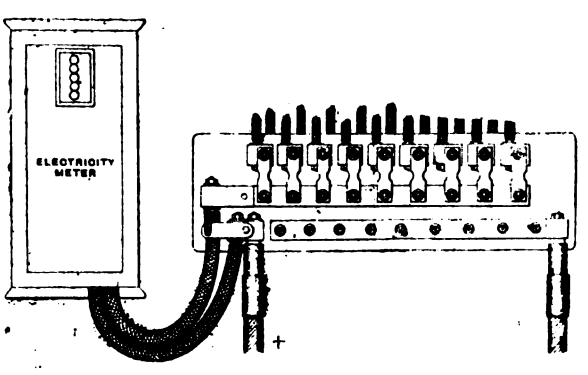

FIG. 5.

the curve obtained from the steady-load tests, Fig. 6. As factors involved in the cost of generating a Board of Trade unit, the steam taken by all the auxiliary pumps had to be taken into account. This was done by condensing the steam exhausted from the feed-pump, air-pump, and circulating-pump and weighing the water discharged. As the feed-pump supplied water to all the boilers, only a part of its steam was taken in the proportion which the air-pump discharging from the condenser bore to the total feed water.

The coal was weighed out of the barges in quantities of 15cwt. at a time; a reliable steelyard was slung on the crane hook

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FIVE HOURS' TESTS OF A WILLANS III COMPOUND ENGINE (No. 2), OF 300 I.H.P., COUPLED TO SIEMENS H.B. 24/36 DYNAMO, 1,500 AMPERES AND 120 VOLTS, AT 350 REVOLUTIONS PER MINUTE.

Experiment.	I.H.P.	Volts.	Amperes.	Watts.	E.H.P.	Board of Trade units.	Pounds of coal per Hour per I.H.P.	Pounds of coal per Hour per E.H.P.	Pounds of coal per Board of Trade unit.	Pounds of steam per Hour per I.H.P.	Pounds of steam per Hour per E.H.P.	Pounds of steam per Board of Trade unit.	Efficiency. Col. 5. / Col. 1.
													Per cent.
1	95 75	120·7	376·2	45,407	60 87	227	2·29	3·945	5·28	20·5	35·2	47·15	63·6
2	149 2	120 05	712·3	85,511	114·6	427·5	2 35	3·06	4·10	21·0	27·3	36·6	76·8
3	209·8	119·75	1,106	132,443	177·5	662·2	2·24	2·656	3·55	20 03	23·7	31·7	84·6
4	268 9	118·2	1,459	172,453	231 2	862·3	2 18	2·545	3·41	19·5	22 7	30·45	86·0
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)

FIVE HOURS' TESTS OF A BELLISS COMPOUND CONDENSING ENGINE (No. 1) 300 I.H.P., COUPLED TO A SIEMENS H.B. 24/36 DYNAMO, 1,500 AMPERES AND 120 VOLTS, AT 350 REVOLUTIONS PER MINUTE.

													Per cent.
1	79·4	120·02	376 0	45,127	60·49	225·6	2·99	3·91	5·24	26·7	34·9	46·8	76
2	144·75	120 05	747·6	89,749	120·3	448·7	2·72	3·28	4·39	24·3	29·25	39·2	83·3
3	212 8	120·32	1,116·8	134,373	180·12	671·9	2·48	2·94	3·94	22·2	26·26	35·2	84·7
4	271·6	121·22	1,418·0	171,890	230·4	859·5	2·51	2·95	3 95	22·4	26·33	35·3	85·1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)

and compared from time to time with standard weights. A sample was taken from each skip, and all the samples were afterwards ground up and well mixed, thus affording a thoroughly representative sample of the coal for analysis. The water was fed from a feed-water heater into a measuring tank holding 6,270lb.; this tank stood over a shallow supply tank, and could be emptied into it through a 6in. valve. The temperature of the feed water was frequently taken. The test was started with a perfectly clean stokehold floor, the furnace having been supplied from a separate store of coal, which was locked up as soon as the use of the weighed coal was commenced. The water levels in the gauge glasses were marked, and the steam pressures and state of fires were noted. A log-book was kept, with the following entries: (1) time of shift (eight hours); (2) name of person in charge of shift; (3) boilers in use; (4) amount of coal weighed into bunkers; (5) state of bunkers; (6) pounds of water fed during shift; (7) mean temperature of feed water; (8) mean steam pressure; and (9) water level in feed-tank at end of shift. At the end of the first week the boilers were worked down to the same condition as at starting, and all the coal used up, feed water noted, etc., to form a check. Then the test was continued, and went on until the month was up, all the conditions being the same at the end.

The engines and dynamos were run for five hours on each load—that is, four tests on each type of engine, eight tests in all on the steady loads. Simultaneously, the auxiliary pumps,

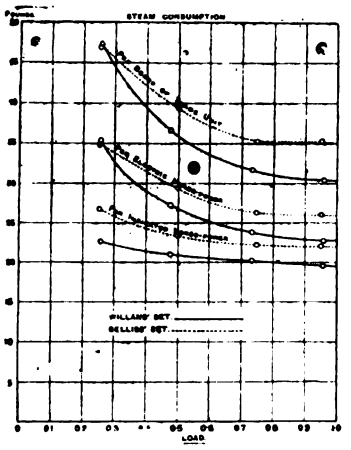

FIG. 6.

etc., were measured, and the electrical output of the dynamos was gauged. The engines were indicated every half-hour, giving 10 sets of diagrams for each load. To ensure simultaneous readings of the electrical instruments and indicators a whistle was blown. The electric current was measured in two ways: (1) by three Siemens ammeters A53 type, which were frequently compared with the standards, in the positions in which they were used, and were set up in such a way as to have no disturbing effect on one another—the readings of these three instruments were adopted; (2) by a large plate of German silver carrying the main current, and having its difference of potential measured at two points by a delicate galvanometer. The two methods described above gave very consistent results, particularly at the two lower loads. The volts were measured by (1) a Siemens torsion galvanometer, checked with the Clark standard cell before and after all the tests, and found correct; (2) a Weston standard voltmeter. These two methods also agreed, the difference being quite negligible. The voltmeters were placed at a distance from any machines or cables carrying current. These readings were adopted. To ensure the greatest possible accuracy in the efficiency tests, all the steam-engine indicator springs were tested by an independent manufacturer, and a correction table applied to the indicator cards.

In making up the cost of a Board of Trade unit, the following items were included: coal, including cost of delivery to bunkers; water, auxiliary pumps, etc.; oil, waste, and sundry stores (for last six months); removal of ashes, engine-room drivers and machine-tenders, electrician and switchboard boy, stokers, and repairs. This cost only refers to the Board of Trade unit at the switchboard, and takes in no charges connected with the distribution plant. The actual results obtained are stated below.

Boiler Efficiency.—Boilers of gunboat type:

	Square feet.
Nos 3 and 4 boilers, heating surfaces—	
Tubes	1,033
Flame-boxes	222
Total	1,255
No. 5 boiler, heating surfaces—	
Tubes	1,110
Flame-boxes	215
Total	1,325

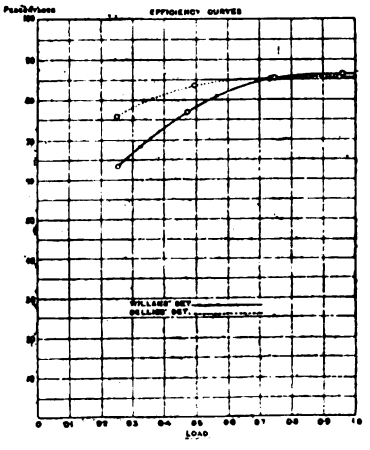

FIG. 7.

The grate area of boilers Nos. 3, 4, and 5 was 41 square feet for each. The duration of test was 356½ hours. The total of boiler-hours was 988. Nixon Navigation coal was used, the mean thermal value of four samples being 14,221 British thermal units. The evaporative power at 212deg. F. was 14·65lb. of water per pound of coal. The mean carbon value of the coal was 0·993. The coal burned per boiler per hour was 625lb., and per square foot of grate area per hour it was 15·25lb.

The water evaporated per boiler per hour was 5,576lb. The weight of water evaporated per pound of coal (including coal used in lighting fires) into steam at a pressure of 127lb. per square inch was 8·923lb. The weight of water evaporated per pound of coal from and at 212deg. F. was 10·083lb. The weight of water evaporated per square foot of total heating surface per hour was 4·42lb. The weight of water evaporated per square foot of grate area per hour was 136lb. If the coal used

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in lighting up be neglected, the evaporative efficiency becomes 9·16lb. of water per pound of coal at a mean pressure of 127lb. per square inch, and 10·35lb. of water per pound of coal from and at 212deg. F. The annexed experiments were made on steady loads (resistance frames):

DAY-LOAD TESTS OF FIVE HOURS, THE VARIATION OF LOAD BEING ABOUT 15 PER CENT.

	Willans engine, etc.	Belliss engine, etc.
Mean current (amperes)	1,167	1,184
Mean pressure (volts)	121·33	126·38
Mean power (watts)	141,592	149,634
Mean electric horse-power	189·8	200·6
Board of Trade units	707·96	748·17
Weight of steam used per electric horse-power per hour (pounds)	23·39	26·2
Weight of steam used per Board of Trade unit (pounds)	31·35	35·1
Weight of coal used per electric horse-power per hour (pounds)	2·62	2·93
Weight of coal used per Board of Trade unit (pounds)	3·51	3·93
Proportion of full load	0·778	0·789

These engines were not indicated, owing to the impossibility of taking simultaneous readings. From these experiments two diagrams have been prepared, one showing the steam consumption per Board of Trade unit, per electric horse-power, and per indicated horse-power (Fig. 6); and the other the efficiency of the steam dynamos (Fig. 7). It will be seen that the steam consumption of the Belliss engine was greater than in the Willans, but it should be stated that this was the first engine of its kind ever built of that description, and that it has the worst position as far as the exhaust steam is concerned. On the other hand, the efficiency shows to greater advantage in the Belliss set, the dynamos being identical. After the consumption of fuel and of water had been determined by these experiments, the value of the stores issued to the central station for the last six months was ascertained, together with the wages paid and the cost of the repairs done to the central station and to all the electric plant, including motors.

The output of the station had been at the rate of 1,797,120 Board of Trade units per annum, representing a load-factor of 0·285. The actual cost per Board of Trade unit was, therefore, for the six months ending October 31, 1894:

	Per Board of Trade unit. Willans. Pence.	Belliss. Pence.
Coal (including cost of delivery and removal of ash), 17s. 5d. per ton. Willans, 3·41lb.; Belliss, 3·95lb. per Board of Trade unit	0·3180	0·3680
Water (7½d. per 1,000 gallons)	0·0228	0·0264
Stores, oil, waste, boiler fluid, etc. (taken from last six months' consumption)	0·0416	0·0416
Wages, stokers, trimmers, drivers, labourers, electrical assistant (half time), and switch-board boy	0·0977	0·0977
Steam for auxiliary pumps, feed (only 0·7 taken), air, and circulating, water 0·003d., coal 0·026d.	0·0290	0·0290
Repairs to central-station plant and motors	0·0802	0·0802
Total cost per Board of Trade unit	0·5893	0·6429
Total cost per electric horse-power per hour	0·440	0·480

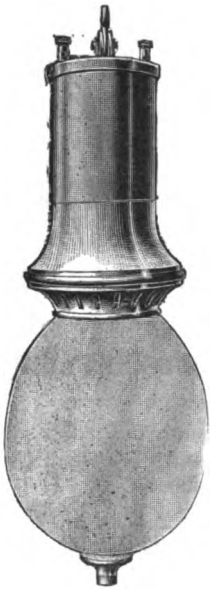
The cost for steam supplied to auxiliary pumps, etc., is too high, as there was only one set exhausting into the main condenser during the tests, and the steam of one circulating pump and the air-pump was charged to this set: probably a very little more steam would suffice for the full working load on the condenser. This cost is that of a Board of Trade unit at the switchboard in the central station. The loss of energy in the cables is not more than 5 per cent., and the average efficiency of the motor being taken at 90 per cent., the cost of a brake horse-power, or 746 watts, may therefore be taken at 0·515d. per hour. No attendance has been charged to the motors, and the expense of oiling is very trifling, especially in motors fitted with Meneely bearings, of which a model was shown. Such bearings were applied to the three bearings of a Siemens H.B. : $^{15}/_{20}$ motor, developing about 40 b.h.p. at 360 revolutions per minute in driving part of the machines in the lead-cable sheathing-shop. Two of the journals are 2¾in. in diameter by 7 3-16in. long, while the third is 3¼in. in diameter by 6 7-16in. long. During the first week's run, one of the roller bearings got rather hot, but not sufficiently so to necessitate stopping the motor; and since that time—the beginning of July, 1893—they have all been running satisfactorily. The consumption of oil after the first few weeks was at the rate of one pint per month for the three bearings.

In order to make a comparison between the outlay for an electric plant and for a steam plant, the author has had a table prepared showing the cost of the old steam-engines and boilers at Messrs. Siemens's works, together with the cost of foundations, erection, and of the chimneys. A statement, similarly, of the cost of the new boilers, of the pipework, of the auxiliary engines, the condensers, the steam dynamos, the cables, motors, switches, and all accessories has been also prepared. In the old steam plant of 1,446 i.h.p., taking into account the long lengths of shafting that had to be driven, the author does not think that more than 60 per cent., or 867 b.h.p., was really utilised. On the other hand, there are now 1,407 b.h.p. available at the motors, and 240 h.p. devoted to electric lighting purposes. The author does not wish to publish the exact costs, but the capital outlay per brake horse-power was 30 per cent. higher in the case of the old steam plant than for the present electric central-station plant. Moreover, the load-factor—viz., the proportion of the actual output of the central station to the possible output, which, as stated above, is 0·285—shows that we can connect to the present generating plant many more motors without much fear of overloading it. There can, therefore, be little doubt that for new works electric transmission of power is certainly more economical than the employment either of separate steam-engines or of transmission by belts or ropes.

Whether a change from the old system to electric transmission can be recommended depends entirely on local circumstances, and this question can only be ascertained by carefully weighing all the factors that come into play. Generally speaking, electric transmission is most applicable where power is wanted at a number of places scattered over the works, and especially in and about mines and collieries. Such a case has lately been investigated by the writer's firm, and they have made an offer to replace various engines, exerting altogether about 800 b.h.p., by an electric plant, comprising a central station similar to that at Messrs. Siemens's works, but having only three boilers and three sets of steam dynamos, all switches, cables, and motors to do the above work for a certain sum. By this conversion the colliery owner would save sufficient money—counting 15 per cent. of his outlay for interest and depreciation—to repay the outlay in 10 years, or, in other words, the cost of working the plant for a year would be less than the present cost by an amount equal to 25 per cent. of the outlay. These figures show that there is a wide field for successfully applying electric transmission of power—in works as well as in mines—where electric motors must be especially welcome, as they do their work without forming any by-products that have to be dealt with by costly contrivances. In these times of ever-increasing competition it is well worth while to utilise all advantages that science places at the disposal of industry, and anything that increases the amount of power at our disposal for each pound of fuel consumed should meet with hearty support in this great centre of mining and industry.

THE "RICHARDSON" BRITANNIA ARC LAMP.

The type of arc lamp illustrated herewith is suitable for both internal and external illumination. It has been specially



designed for working on central-station circuits, and is readily handled and trimmed by those unskilled in the use of arc lamps. The lamp is of the differential-focussing brake-wheel type, and is mechanically and electrically as perfect as possible. The magnets are of a large area, and are, therefore, not liable to become unduly heated. The working parts are few, and, having a most perfect feed, the light is absolutely steady. We are informed that this lamp, which is made by Mr. A. W. Richardson, of Patricroft, near Manchester, has been adopted by many engineers and companies, and that it is at work on most of the existing Corporation electric light supply mains.

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THE RECENT ACCIDENT AT BRISTOL.

Major Cardew, R.E., has held an enquiry this week at the Guildhall, Bristol, as to the circumstances of the fatality which happened on February 25 in one of the transformer-rooms of the Bristol Electric Lighting Department, by which Robert Coleman lost his life. Mr. D. Burges (town clerk) and Mr. Wise represented the Corporation, and there were also present Mr. George Pearson, chairman of the Electric Lighting Committee, and Mr. Faraday Proctor, the chief electrical engineer.

Wm. J. R. Wilcocks, an improver at the Corporation electric light works, said that on February 25 he was at the Old Market-street transformer-room with Coleman, who removed the fuses of the high-tension fuse-board. He then proceeded to dust the board and brass terminal, and at the commencement did so with his right hand, upon which he had an indiarubber glove. He meanwhile kept his left hand in his pocket; but after a time he used it for holding the other end of the duster, and worked with both hands. In this way he cleaned three of the terminals, and was doing another, when he looked up as if to speak to witness. As he did so the knuckles of the left hand touched the terminal, the deceased uttered a sharp cry, and went up on his toes perfectly rigid. His hand was not clutched on the terminal, but there was a "sizzling" noise. He seemed perfectly rigid, and looked unconscious. He was leaning towards the board, and that kept him in contact. Witness went behind him, caught his coat, and pulled him off. This was a matter of a few seconds. Artificial respiration was tried. Dr. Page was sent for, and he continued to try artificial respiration, but without avail.

William Coleman, brother of the deceased, gave evidence of the deceased having had 13 years' electrical experience, 11 years being at telephone works, and the remaining two years at Messrs. Siemens Bros. and the Corporation electric light works. The deceased was aware of the danger of touching any high-pressure terminal.

Dr. Page gave evidence that he had made a *post mortem*, which led him to believe death was due to electric shock. The death was practically instantaneous.

With Mr. Faraday Proctor, and several others connected with the electrical department, the inspector then went to the cellar where the transformers are placed, at 76, Old Market-street. There **Mr. Faraday Proctor** explained how the accident occurred. The deceased had simply to dust the fuse-board, and should have done so using only one hand, and that protected by a non-conducting indiarubber glove. Instead he used both hands, his left being unprotected. He took the duster, one end in each hand, and placing it in a U-shaped slot in the terminal, moving the duster backwards and forwards. He need not have dusted the slot. While doing so he looked towards another employé of the Corporation, as if about to speak, and inadvertently touched with his bare hand one corner of the terminal in which the slot was. He at once fell forward over the board, but was pulled back by the other employé, Mr. Wilcocks. He did not touch both terminals; the current, which came from the central generating station at a pressure of 2,000 volts, passed through his body to the ground and killed him.

The **Inspector** made a series of suggestions, with a view of increasing the safety of those who might have to work in the cellar. One was that there should be a substantially-made guard of vulcanite, or other non-conducting material, around the terminals where they, bare of any insulation, projected on the fuse-board; and that the bare terminals and projected fittings be painted with the non-conducting red solution used for such work. Major Cardew further suggested that, as there was plenty of room in the cellar, there might be a reserve board to which the high-pressure current could be switched while one board was being cleaned, the floor of the cellar be laid with asphalte so as to obviate danger of earth connections, and indiarubber boots used as a precaution.

Mr. Faraday Proctor made a note of the suggestions, which it was understood, although not expressly stated, applied to the other transforming stations (14 in number) owned by the Corporation.

THE PROPOSED PACIFIC CABLE.

The following is a copy of further correspondence between Sir Charles Tupper and Sir John Pender on the subject of a proposed Pacific cable:

SIR CHARLES TUPPER TO COLONIAL OFFICE.

Victoria-chambers, 17, Victoria-street,
London, S.W., Dec. 12, 1894.

Sir,—I have observed that in the recently issued parliamentary paper [C. 7,553] relating to the Colonial Conference at Ottawa a letter from Sir John Pender to the Marquis of Ripon, dated June 2, 1894, enclosing certain correspondence between him and myself, is printed (pages 367-371).

After the date of that communication, however, a further correspondence took place between Sir John Pender and myself on the subject at issue, which should be read in conjunction with that presented to Parliament in the Blue-book referred to.

I therefore beg to enclose herewith a copy of this later correspondence for the information of Lord Ripon, and for publication if his lordship sees no objection.—I am, etc.,

CHARLES TUPPER.

SIR CHARLES TUPPER TO SIR JOHN PENDER.

Office of the High Commissioner for Canada,
17, Victoria-street, London, W.C.,
June 4, 1894.

Dear Sir John Pender,—In reply to your letter of the 30th of May, I beg to remind you that we joined issue on the following points: 1. Whether the "existing service was established solely by private enterprise." 2. Whether the life of a cable is 14 years. 3. Your assertion that my "description of the existing system as a monopoly cannot be justified." 4. That a Pacific cable has no strategic value.

I respectfully submit that the admission that the "existing service" has already received Government subsidies exceeding £2,000,000 settles the first issue.

You reject the authority of the Berne list, for the accuracy of which I supposed you were responsible, quoted by me in support of my contention as to the life of a cable, but you have not met my quotation from a recent speech of your own, which showed the life of a cable to be nearer 25 years. Permit me to quote the further evidence of another high authority on that question—your late colleague, Sir James Anderson—who was knighted for laying the first successful cable between England and America. In October, 1886, at a meeting of the Direct Spanish Telegraph Company, Sir James Anderson, presiding, said: "They estimated the life of the Barcelona cable at 25 years." It had then been in operation 13 years, and great improvements have been made in the manufacture of cables since the Barcelona cable was constructed. I think I may now fairly consider the second part of our controversy disposed of.

As to the "monopoly" question, you intimate that Mr. Raikes was misled by Mr. Fleming. I will now give you an authority which I am sure you will respect, for it is your own. I find the following statements in a letter written by you to Sir Henry Holland, dated April 18, 1887: "If reference is made in any way to the existing companies as a monopoly, my answer is that it has been so created by the great energy with which the company have carried on their extensions. . . . I would also draw your attention to the fact that, while it has been made a monopoly through the circumstances I have stated," etc. While this public record remains, you will, I imagine, hardly repeat the statement that I am not justified in considering the "existing system as a monopoly."

As to the question of the strategic value of a Pacific cable, not only the *Globe*, from which I quoted, but the Press generally of this country, of Australasia, and Canada have been emphatic in their declarations in opposition to your views, nor can I see how any disinterested man can hold any other opinion. The cable communication between this country and India and Australasia passes through several foreign countries, and in the contingency of a European war could not be relied on.

You say, in reply to the statement in the *Globe*, that, in the case of your cable between Aden and Bombay being injured communication with India would be interrupted, that you have three other routes practically under your control. I suppose the three routes you refer to are those given in the official maps of the International Bureau: (1) through Russia, Siberia, Japan, and China; (2) through Germany, Russia, and Persia to Kurrachee; (3) through Constantinople and the Euphrates Valley to Kurrachee.

I am not aware that these long overland lines are under the control of the Eastern Telegraph Company.

For Imperial purposes, the first and second routes present insuperable difficulties, and I do not think that your experience in telegraphy with India will lead you to consider as reliable the Euphrates Valley line, which belongs to the Turkish Government, and passes through a country bristling with physical difficulties, rendering the maintenance of good communication almost impossible. You must, however, admit that if the Indian land wires in the neighbourhood of Kurrachee and Bombay were interrupted, all communication by telegraph between these towns and Calcutta, Madras, and Australia would require to be transmitted to Europe for retransmission through the only remaining route open to the East—viz, through Russia, Siberia, Japan, and China. An all-British line, *vid* Canada to Australia, remote from any hostile influence, might at any moment, therefore, become vital to the best interests of the Empire. As to the financial prospects of this enterprise, I am glad to find that you have revised the estimate you submitted to Lord Ripon in April, and now make the deficit £48,000 instead of £120,000, at which you then stated it. I beg to suggest that if you will place the amortisation of the cable at 25 years, and add the receipts of the large volume of United States and Canadian traffic that will be created by a Pacific cable, and make fair allowance for the usual increase of traffic, your latest calculation will be considerably modified. Allow me to add that your adherence to 14 years as the life of the cable in order to show the scheme financially impracticable will in my opinion convince many persons that the enterprise cannot be condemned by fair calculations.—I remain, etc.,

CHARLES TUPPER.

Sir John Pender, G.C.M.G., M.P.

P.S.—I am sending this letter to the *Times*.

SIR JOHN PENDER TO SIR CHARLES TUPPER.

The Eastern Extension, Australasia, and China Telegraph Company, Limited,
Winchester House, 50, Old Broad-street, London, E.C.,
June 6, 1894.

Dear Sir Charles Tupper,—I have received your letter of the 4th inst., from which it is quite clear that our views on the Pacific cable question are so divergent that no practical purpose will be served by continuing the correspondence any longer.

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But before closing it permit me to briefly deal with the principal points raised in your last letter, and to express the hope that the facts and figures which have been elicited by the correspondence may be found useful to the Ottawa conference, and more particularly to the investing public, who will eventually have to decide the question, if it is to take a practical shape.

With regard to the first point, I think any unprejudiced person reading my previous letter will have been convinced that the pioneer service to Australia was established solely by private enterprise, and that the Government subsidies granted years afterwards for an entirely different purpose have no bearing on the argument.

As to the second point, it is true that there are cables still working which were laid 25 years ago; but, on the other hand, many cables equally well manufactured and laid have been known to require entire renewal in as short a time as 12 to 17 years after they have been submerged. In short, the life of a cable is notoriously uncertain, depending very largely on the locality and nature of the bottom over which it is laid, and it is therefore impossible to accurately measure such an unknown quantity. I have never, however, asserted that a Pacific cable would last only 14 years. All I have done is to base my calculation for amortisation on the period fixed by the Wellington conference for the proposed guarantee—viz., 14 years.

If, however, we take 20 years, which is the more usual period for subsidy or guarantee arrangements of this kind, as the basis of calculation, the financial result to an investor would still be most disappointing, as shown by the following figures:

Capital		£1,800,000
Working expenses	£25,000	
Maintenance	35,000	
	£60,000	
Amortisation to replace capital at end of 20 years	67,000	
		£127,000
Less earnings estimated on basis of one-half existing traffic	45,000	
Four per cent. guarantee	72,000	
		117,000
Leaving an actual loss to investors of		£10,000

And if the Pacific cable were duplicated, which I contend would be absolutely necessary to make it a successful competitor to the existing system, the loss would, of course, be immensely greater.

When writing to Sir Henry Holland the letter to which you refer, I was endeavouring to meet objections raised by opponents to the strong position which we had built up, and which had been described as a monopoly. As a matter of fact, our control of the Australian traffic has never depended on the possession of exclusive privileges, which alone would constitute a monopoly in the strict sense of the word, but it has been the result of good businesslike work carried out on strictly economical principles.

As to the strategic question, I can only express surprise that you should think a Pacific cable would be safer in time of war than the existing cables, which follow the principal trade routes, where British war-vessels would presumably be found in far greater force than in such a remote region as the Pacific Ocean.

The three alternative routes which I had in mind when referring to the *Globe* article were (1) the cables from England to Aden round the coast of Africa; (2) the Indo-European Company's system; (3) the Great Northern Company's system.

With the Indo-European and Great Northern Companies we have working agreements, and the first named route is, to a large extent, owned by the Eastern Company.

With regard to your last point, the only difference between the figures submitted to Lord Ripon and those given in my letter of the 30th ultimo is that in the one case the deficit includes 4 per cent. interest on capital, and in the other the deficit is shown without interest. But the practical result to an investor is precisely the same, and, with such figures before you, I would again ask whether you would be prepared to put your name to a prospectus inviting subscription from the public for such an unprofitable scheme.

Having now answered your letter the correspondence must cease, as your time and mine is much too valuable to be taken up with an academic discussion of this kind. If, however, the question should take a more definite shape, I shall be happy to resume the discussion with a view to arriving, if possible, at a practical result.—Yours faithfully, JOHN PENDER.

To the Honourable Sir Charles Tupper, Bart., G.C.M.G., C.B.

SIR CHARLES TUPPER TO SIR JOHN PENDER.

Office of the High Commissioner for Canada,
17, Victoria-street, London, S.W.,
June 8, 1894.

Dear Sir John Pender,—I am not surprised to find by your letter of the 6th inst. that you wish to close the correspondence which you initiated, and I cannot help thinking that those who have followed it will wonder why it was ever commenced. I am quite satisfied to leave all the questions at issue to the judgment of the public. Your admission that the "existing service" has already received over £2,000,000 of Government subsidies; that the life of a cable may fairly be estimated at 20 years; and that you are responsible for the statement that the existing service to Australasia is a "monopoly" is very satisfactory to me. I am also glad that I have been able to induce you again to revise your estimate. In reply to your question, I venture to suggest that capitalists will not be influenced in this matter by your opinion or mine, as their decision will depend upon the action of the Governments of the United Kingdom, Australasia, and Canada.—Yours faithfully, CHARLES TUPPER.

Sir John Pender, G.C.M.G., M.P.

KINGSTON-UPON-HULL ELECTRIC LIGHTING ACCOUNTS.

The accounts of the electric lighting department for the year ended October 31, 1894, have been issued. The capital expenditure during the year amounted to £6,212 and the total expenditure to December, 1894, has reached the sum of £39,031. Below is given the revenue account and general balance-sheet.

GENERAL BALANCE SHEET.

Liabilities.		£ s. d.
Net revenue account—balance at credit thereof December 31, 1893		13 2 4
Balance at credit thereof December 31, 1894		1,053 1 2
Amount due to treasurer—revenue account to December 31, 1894	£1,185 2 11	
Ditto, capital account, ditto	39,031 13 9	
		40,216 16 8
		£41,283 0 2

Assets.		£ s. d.
Capital account—amount expended for works		38,743 14 1
Stores on hand at December 31, 1894—coal £31. 2s.; oil, waste, etc., £17. 18s. 7d.; general, £287. 19s. 8d.		337 0 3
Sundry debtors for current supplied to December 31, 1894, £2,151. 19s.; other debtors, £50. 6s. 10d.		2,202 5 10
		£41,283 0 2

REVENUE ACCOUNT.

Dr. A.—To Generation of Electricity.		£ s. d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£528 0 4	
Oil, waste, water, and engine-room stores	78 8 9	
Wages at generating station	424 9 2	
Repairs and maintenance as follows: buildings, £7. 12s. 3d.; engines and boilers, £92. 5s. 3d.; dynamos, exciters, transformers, motors, etc., 4s. 5d.; other machinery, instruments, and tools, £14. 14s. 10d.; accumulators and accessories, £15. 6s. 2d.	130 2 11	
		1,161 1 2
B.—To Distribution of Electricity.		
Wages and other remuneration to linesmen, fitters, labourers	81 12 1	
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	59 1 4	
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of materials and lamps sold	5 3 4	
Repairs, maintenance, and renewals of apparatus at distributing stations	0 8 6	
		146 5 3
E.—To Rents, Rates, and Taxes.		
Rents payable	105 1 0	
Rates and taxes	37 19 0	
		143 0 0
F.—To Management Expenses.		
Salaries (engineer's department)	343 8 4	
Printing and stationery	70 7 0	
General establishment charges	116 14 10	
		530 10 2
G.—To Law and Parliamentary Charges.		
Law expenses		4 2 3
H.—To Special Charges.		
Insurance, etc.		18 19 10
		£2,003 18 8
Amount carried to net revenue account		2,944 2 3
		£4,948 0 11

Cr.	£ s. d.
Sale of current per meter, 5d, 5½d., and 6½d. per B.T.U.	4,601 1 9
Rental of meters and other apparatus on consumers' premises	115 14 2
Other items, miscellaneous	182 4 5
Stores on hand December 31, 1894	49 0 7
	£4,948 0 11

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Net Revenue Account.	£	s.	d.
Interest on mortgage debt accrued due to date, less £125 allowed overcharged on last year's account*	931	1	7
Loan	959	19	6
Balance carried down	1,053	1	2
	£2,944	2	3
	£	s.	d.
Balance brought from revenue	2,944	2	3
	£2 944	2	3

* The overcharge was made in assuming we should have to pay 3½ per cent. for our loan, whereas we are only to pay 3 per cent.

LEGAL INTELLIGENCE.

INCANDESCENT ELECTRIC LAMP COMPANY v. BRUSH ELECTRICAL ENGINEERING COMPANY.

This, case, which was an action for damages for breach of a covenant for quiet enjoyment, was heard last week before Mr. Justice Wright, without a jury.

Mr. Lawson Walton, Q.C., and Mr. Loehnis appeared for the plaintiffs, and Mr. Bigham, Q.C., and Mr. Tindal Atkinson for the defendants.

The plaintiffs are under-lessees of certain premises at Brook Green, Hammersmith, under a lease of September 20, 1893, from the defendants, containing the covenant for quiet enjoyment now sued on. The defendants were entitled, under a lease of February 21, 1889, from Mr. P. J. M'Manns, granted to the defendants by their then name of the Anglo-American Brush Electric Light Corporation, Limited. A portion of the land conveyed by these leases was and is used as a roadway by the Compressed Air Carpet and Tapestry Cleaning Company, who hold the adjoining premises under a lease from Mr. M'Manns, and there is no other approach to their works. On February 21, 1889, the defendants granted to Mr. M'Manns a right of way to the premises now occupied by the Carpet Cleaning Company for two years, or for such less period as he should reasonably require for obtaining another entrance into the said premises, and he agreed at the end of that time to block up the roadway. This agreement was subsequently extended till a certain private road, leading to the premises, should be taken over by the local authority. This had never happened ; no other entrance to the premises of the Carpet Cleaning Company was ever made, and damages were claimed for the continued use of the roadway by the latter. The plaintiffs claimed that the defendants ought to have compelled Mr. M'Manns to open another entrance and close up the roadway.

Mr. Justice Wright said that he regretted that he need not call on Mr. Bigham. Judgment would be for the defendants, with costs. This would not hinder the plaintiffs in any action they might bring for rescission of the contract, if they entered into the lease under the impression that the right of way was merely temporary. Stay of execution, pending appeal, was granted on the usual undertaking.

COMPANIES' MEETINGS AND REPORTS.

CAMBRIDGE ELECTRIC SUPPLY COMPANY, LIMITED.

The annual meeting was held at the Company's office, Thompson's-lane, on Wednesday last week, under the presidency of Mr. D. Munsey, chairman.

The **Chairman**, in moving the adoption of the report and accounts (which were published in our issue of the 22nd ult.), said that when the previous balance-sheet was sent out they had issued 2,275 shares, which gave them a capital of £22,200. Last year they issued 807 new shares, which added £6,456 to their capital. During the two months of this year they had had applications for 450 new shares, bringing in £3,600 capital. The debenture stock, which last year stood at £7,000, was now £4,000, while they also had a balance of £500 at the bank, so that practically they were £100 to the good. The interest on the debenture stock during the year had been reduced from 5 to 4 per cent. As there was only one other company paying so low as 4 per cent. on debenture stock, he thought they might be congratulated on the arrangements they had made. The amount owing to creditors in 1893 was £1,500, while at the end of last year it was £175, chiefly for current expenses during December. The numbers of consumers had increased from 176 to 260, the number of units sold was 44 per cent. more than in 1893, and this had only cost an extra 5 per cent. in the working expenses. The number of lamps had increased by 29 per cent. It was proposed to instal a small new machine which would not consume so much coal. They also proposed to have a new boiler. The directors were pleased to be able to recommend the payment of a dividend of 2½ per cent. The Chairman then moved the adoption of the report.

Mr. Sturton seconded the motion, at the same time criticising the balance-sheet.

A **Shareholder** asked if the directors proposed to have a reserve fund. He thought they ought to.

The **Chairman** said that matter had been before them, but as it was a new Company they felt that they need not do anything that year. He was almost certain that next year they would be able not only to declare a better dividend, but also to lay something by for a reserve fund.

The motion was then put to the meeting and adopted.

Mr. C. A. Parsons said that was the second year of the Company's work, and that he hoped as time went on it would pay a larger dividend. They had just turned the corner, and were now making good progress. He thought they were justified in declaring a dividend nearly equal to the earnings of the Company, as the machinery and works were new. He moved that a dividend at the rate of 2½ per cent. be paid.

Dr. Latham seconded, saying the Company was to be congratulated on the success which had attended it, and for the careful way in which matters had been supervised by the chairman.

The motion was carried unanimously.

Sir Benjamin Brown and Mr. D. Munsey, the retiring directors, were re-elected, and Mr. A. Rutter was re-elected auditor. The directors were voted the sum of £100 for the work of the past year, and a vote of thanks terminated the proceedings.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

The annual ordinary meeting was held on Tuesday at the central station, Draycott-place, Chelsea, Mr. J. J. Courtenay presiding.

The **Chairman**, in moving the adoption of the report, which was published in our last issue, stated that the satisfactory result of the year's working was partly due to a reduction on all the items of expenditure relating to the production of electricity, and partly to increased volume of business. Although they had had to pay a larger price per ton for coal (an average of 9 per cent. higher than in 1893), the coal used to produce each unit came out at a lower cost ; wages, stores, and maintenance were also less. The expenditure of £4,979 on mains was for extensions arising out of the increased demand. The mains laid were capable of taking a supply for a large number of lamps with little or no additional expenditure ; and as the erection of new buildings as leases fell in was likely to continue, they hoped for a larger return on the capital already spent. There was no question that an important element to be considered when estimating in any given residential district the probable annual increase of lamps was as to what was the amount of rebuilding actually in progress or in view ? No company had better prospects in this respect than the Chelsea, as in no part of the Metropolis were more important alterations and improvements in progress than in its district, while the houses were mostly wired when building. The capital expenditure per lamp (£2. 9s. 4d.) fixed was as low as that of any other company in the Metropolis. The premises at Cheyne-walk would be able to contain plant sufficient, when fully equipped, to supply the needs of 50,000 or 60,000 lamps.

The report, having been seconded, was adopted.

HOVE ELECTRIC LIGHT COMPANY, LIMITED.

Directors : Colonel A. J. Filgate, R.E. (chairman), Colonel H. Wood, C.B. (vice-chairman), Harold A. Hoare, Esq , Carleton F. Tufnell, Esq. Engineers : Messrs. Crompton and Co., Limited. Secretary : Francis R. Reeves, Esq.

Report of the directors to be presented to the shareholders at the annual general meeting to be held at the City Terminus Hotel, Cannon-street, E.C., on Tuesday, March 12, 1895.

The progress of the Company continues in every way satisfactory ; the supply of current to consumers has been carried on without a single hitch ; whilst the machinery, batteries, and mains supplied and laid by Messrs. Crompton and Co., Limited, have given perfect satisfaction to the Board during the whole year. The number of lamps attached to the Company's mains has increased from the equivalent of 6,915 8-c.p. lamps at the date of the last annual report to 16,473 at the present time, whilst the number of consumers has increased from 105 to 233 in the same period. The sale of current per meter, which realised £1,265. 18s. 10d. during 1893, shows an increase to £3,508. 6s. 9d. during 1894, while the result of the past year's working has been a profit of £1,243. 0s. 5d., as against £77. 5s. 8d. for the previous 12 months. After deducting £563. 17s. 11d. for interest accrued on loans and debentures, a net balance to the credit of revenue account remains of £679. 2s. 6d., as compared with a corresponding figure of £1. 2s. 8d. at close of 1893. In dealing with the £680. 5s. 2d. thus available for division, the directors propose to write off £73 from the suspense account, to declare a dividend for the year at the rate of 3 per cent. per annum upon the shares of the Company, absorbing £594. 10s. 2d., and to carry the balance, £12. 15s., forward. The debentures offered to the public in March last were readily subscribed, but the shares were not so taken, and in consequence further capital is now required to discharge the bankers' loan and to meet the liabilities to the contractors and the cost of the additional machinery which the directors foresee will be required to supply the demand for current next autumn. The directors therefore invite subscriptions from the shareholders for the remaining 3,498 shares at par upon the enclosed form of application. The list for these applications will remain open until the general meeting on March 12, after which, should any remain unalloted, the directors propose, in view of the established position of the Company, to offer them to the public at a premium. It is with regret that the directors announce that in consequence of the pressure of other business Mr. John Wilkes has felt obliged

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to resign his seat on the Board. The directors do not propose to fill up the vacancy. Mr. Harold A. Hoare retires from the Board by rotation, and, being eligible, offers himself for re-election. Mr. Robert Payne, F.C.A., the auditor of the Company, also offers himself for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1894.

A.—To Generation of Electricity.

Dr.	£ s. d.	£ d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	606 7 2	
Oil, waste, water, and engine-room stores	113 12 2	
Proportion of salaries of engineers, superintendents, and officers	184 11 0	
Wages and gratuities at generating station	340 4 8	
		1,244 15 0
B.—To Repairs and Maintenance.		
Amount set aside in accordance with the contract with Hove Commissioners	200 0 0	
Excess of expenditure over provision	32 11 10	
		232 11 10
C.—To Rents, Rates, and Taxes.		
Rents payable	180 13 5	
Rates and taxes	50 12 2	
		231 5 7
D.—To Management Expenses.		
Directors' remuneration	350 0 0	
Salaries	299 12 6	
Stationery and printing	40 2 5	
General establishment charges	112 6 1	
Auditor of Company	10 10 0	
		812 11 0
E.—To Special Charges.		
Insurances		52 12 3
Hire of boiler		100 0 0
Total expenditure		2,673 15 8
Balance carried to net revenue		1,243 0 5
		£3,916 16 1

Cr.	£ s. d.	£ s. d.
Sale of current per meter (107,218 units), after allowing rebates and providing for bad debts	3,508 6 9	
Public lighting	108 13 0	
		3,616 19 9
Rental of meters and other apparatus on consumers' premises		211 11 4
Rents receivable	67 0 0	
Transfer fees	2 5 0	
Installations, etc.	19 0 0	
		88 5 0
		£3,916 16 1

NET REVENUE ACCOUNT FOR THE YEAR ENDING DEC. 31, 1894.

Dr.	£ s. d.
Debenture interest paid November 1, 1894	318 6 11
Ditto accrued due December 31	104 3 4
	422 10 3
Interest on temporary loans	141 7 8
Balance	680 5 2
	£1,244 3 1

Cr.	£ s. d.
Balance from last year	1 2 8
Balance brought from revenue account	1,243 0 5
	£1,244 3 1

GENERAL BALANCE-SHEET, DEC. 31, 1894.

Dr. Liabilities.	£ s. d.
Capital account—amount received	22,255 0 0
Debentures issued	12,500 0 0
Loans from bankers	10,000 0 0
Sundry creditors, due on construction of plant and machinery, fuel, stores, etc., to December 31, 1894	5,894 13 6
Consumers' deposits	77 10 0
Creditors for interest	174 6 8
Net revenue account—balance at credit	680 5 2
	£51,581 15 4

Cr. Assets.	£ s. d.
Capital account—amount expended for works	48,828 5 7
Stores on hand December 31, 1894—coal, £53. 16s. 3d.; oils, waste, and general stores, £40. 2s. 9d.	93 19 0
Sundry debtors for current supplied, etc., to December 31, 1894	2,246 8 7
Cash at bankers—Messrs. Barclay and Co., £407. 16s. 1d.; cash in hand, £5. 6s. 1d.	413 2 2
	£51,581 15 4

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Manchester.—The Manchester, Sheffield, and Lincolnshire Railway Company require tenders by the 19th inst. for the supply, among other stores, of telegraph materials, tools, and oil.

Brentford.—The Urban District Council require tenders by the 12th inst. for the supply and fixing of telephones and electric calls in connection with the fire brigade. Further particulars were given in our last issue.

Leicester.—The Watch Committee of the Corporation invite tenders by the 15th inst. for the supply of copper lamps and iron columns. Full particulars may be obtained by applying to the superintendent of lighting, Mr. John Tebb, Lamp Office, Town Hall.

Stowmarket.—The Urban District Council require by April 15 tenders for lighting the streets of Stowmarket from August 15 next to May 15, 1896, and also for lighting the post office clock. Particulars as to the number of lamps and time of lighting may be had of Mr. S. Prentice, clerk.

Bradford.—As will be seen by our advertisement columns, the Corporation require tenders by the 28th inst. for the construction and delivery of two steam dynamos for their electricity works. Specification may be had on application to Mr. Baynes, Electricity Department, Town Hall, Bradford, on payment of £1. 1s.

Llanelly.—The Borough District Council desire plans, designs, specifications, and estimates of cost for the supply and installation of electrical plant and machinery, including street lamps and laying down mains. Plans of the district can be obtained from Mr. George Watkeys, C.E, borough surveyor, Llanelly. The plans, etc., are to be sent to the clerk of the Council before the 25th inst. Details are given in our advertisement columns.

Eccles (Lancs.).—The Corporation desire by the 16th inst. tenders for an electric light installation at their sewage farm works, Peel Green-road, Patricroft. Specification of work required and all particulars may be obtained from the engineer, Mr. H. Leonard Hinnell, A.M.I.C.E. (Hinnell and Murphy), 15, Mawdsley-street, Bolton, on deposit of 10s., which will be returned on receipt of a *bonâ fide* tender. Tenders are to be sent to Mr. Geo. Wm. Bailey, town clerk, Town Hall, Eccles, addressed to the chairman of the Sewage Committee.

RESULTS OF TENDERS.

Tunbridge Wells.—The tender of Messrs. Strange and Sons, of Tunbridge Wells, has been accepted, at £140, for constructing three underground transformer stations for the Lighting Committee.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—The receipts for the past week were £3,073.

Commercial Cable Company.—This Company has declared a quarterly dividend of 1¾ per cent.

Great Northern Telegraph Company.—For the month of January the receipts were £21,200.

Wells.—A meeting of the Town Council is to be held on Monday to consider the question of gas *versus* electric light.

Blackpool.—The electric light is being installed in the Victoria Hotel, about 160 lamps being provided for all the principal rooms.

Eastern Telegraph Company.—The receipts during February were £62,342, as against £54,904 for the corresponding period of 1894.

St. George's, S.E.—The Vestry have disapproved of the construction of transformer-chambers in any of the thoroughfares of the parish.

Cuba Submarine Telegraph Company.—For the month of February the receipts were £361 more than for the corresponding period of 1894.

Ballymoney.—Several members of the Town Commissioners have suggested the adoption of the electric light or lighting the streets by oil lamps.

Direct Spanish Telegraph Company.—The receipts for the month of February were £1,690, as against £1,698 for the corresponding period of last year.

Eastern Extension Telegraph Company.—For the month of February the receipts show a decrease of £974 as compared with the corresponding period of 1894.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 3rd inst. amounted to £934, as compared with £635 in the corresponding week of last year.

Brazilian Submarine Telegraph Company.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, tax free, for the quarter ended December 31.

City and South London Railway.—The receipts of the Company for the week ended March 3 were £953, against £934 for the corresponding week of 1894, or an increase of £19. The total receipts for the current period of the present half-year are £8,940, against £8,544 in the corresponding period of 1894, an increase of £396.

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Hull.—The Electric Light Committee of the Corporation announce that there has been a profit of £1,000 upon the year's working of the electric light station. It has been resolved to reduce the price of current to consumers from 6½d. to 5½d. per unit.

Burton-on-Trent.—Alderman Lowe, in moving the adoption of the Gas and Electric Light Committee's report at a meeting of the Town Council on Wednesday, stated that the working of the electric light station during the past year had resulted in a loss of £1,802.

Sale of Business.—"Z. Y.," care of Messrs. Dawson's, 161, Cannon-street, E.C., having started a branch electrical business in a provincial city, and not having sufficient capital to carry it on and extend it properly, is desirous of meeting with a purchaser.

Huddersfield.—The Corporation are about to open a showroom for the purpose of exhibiting electrical appliances. Firms desiring to exhibit special apparatus or machinery may apply to Mr. A. B. Mountain, borough electrical engineer, St. Andrew's-road, Huddersfield.

Electro-Chemical Agency.—In the matter of the British Electro-Chemical Agency, Limited, a petition has been presented to the High Court of Justice (Chancery Division) for confirming a resolution of the above Company for reducing its capital from £75,000 to £50,000.

Hastings.—The Hastings and St. Leonards-on-Sea Electric Light Company have decided to devote their entire attention to the generation and distribution of electricity, and now invite tenders for the purchase of their installation business, with a useful stock of fittings, etc.

Kendal.—The Town Council, on the advice of the Gas and Water and Electric Light Committee, have resolved to oppose the application of the Windermere and District Electricity Supply Company for a provisional order under the Electric Lighting Acts, and to supply electrical energy themselves.

Redditch.—The Urban District Council, in regard to complaints as to the inadequate lighting of the town, have given instructions to the Public Works Committee to enquire into the existing lighting arrangements with a view to their improvement, and a deputation has also been appointed to confer with the directors of the gas company on the subject.

Brush Electrical Engineering Company.—The directors have declared an interim dividend for the six months ended December 31, 1894, at the rate of 6 per cent. per annum on the preference shares, and at the rate of 5 per cent. per annum upon the ordinary shares, payable on the 18th inst. The transfer-books of the Company will be closed until the 19th inst.

Maidstone.—The Urban District Council last week adopted the report of the Electric Lighting Committee, who stated that they had had an interview with Mr. Thomas King (manager to Mr. R. Dann), who was anxious to negotiate with the Council for a transfer of the order, and that he should be requested to send in full particulars of the scheme for consideration.

Electric Power in Mining Operations—Some new machinery is being put in the Robinson mine in South Africa. In addition, electric plant is being constructed for all the pumping plant, as well as for lighting purposes Moodies' electrical power installation having been completed, conductors have been laid to the United Ivy, Ivy Extension, and Agnes block.

Queenstown.—The Town Commissioners, having received a letter from the Queenstown Gas Company, in which it was stated that the directors could not see their way to giving a reduction in the price of gas per lamp, decided to adjourn the consideration of the letter to a special meeting, when it will be considered with a report on the proposed lighting of the town by electricity.

Wednesfield.—The Clerk to the Urban District Council mentioned to the latter last week that the Council might very well consider the question of having the electric light. He stated that there was plenty of engine power in Wednesfield, and it would, perhaps, be possible to rent that power and lay down plant. The suggestion does not appear to have met with any support.

Business Announcement.—The Unbreakable Pulley and Mill Gearing Company, Limited, of West Gorton, Manchester, inform us that they have appointed Messrs. McKenzies, Limited, of Camden Quay, Cork, and Messrs. J. P. Evans and Co., of Limerick, as their sole agents in those districts for the sale of their "Unbreakable" pulleys, adjustable swivel bearings, bright steel shafting, etc.

Sale of Plant.—"Solicitors," care of Gould's Advertising Offices, 54, New Oxford-street, W.C., have for disposal in Clerkenwell, as a going concern, plant and machinery, including a 9-h.p. gas-engine, 24 surfacing and polishing lathes, screw stamping-press, vices, forge, tools, chucks, circular saw benches, etc., together with office fittings. A lease of the workshop and house would be granted.

Messrs. Swinburne and Co., Limited.—Mr. Holt, late managing director, has been appointed general manager of this Company, with the control of their affairs as from January 1, 1895. The Company report that they are extremely busy at present, having more orders and enquiries than at any previous period. They have now opened a showroom at 66, Victoria-street, Westminster, where many of their specialities are on view.

Liverpool.—The Special Lighting Committee of the City Council met on Monday to consider the terms which the Electric Light Supply Company are prepared to accept from the Corporation for their undertaking. The negotiations have been in progress for several weeks, and the final stage was reached the other day, when the committee were informed as to the amount the company would probably take and the conditions under which the business could be acquired.

Bradford.—The Gas and Electricity Committee of the Town Council last week accepted tenders for the supply of 13,000 tons of cannel coal. A discussion also took place with regard to the proposed extension of the electricity works and the proposal to buy land in Valley-road for new works. It was eventually determined that a special meeting of the committee should be held, when the suggested site for new works will be visited and the proposals will be fully discussed.

Hampstead, N.W.—The Vestry last week adopted a report of the Lighting Committee to the effect that the remuneration of Mr. W. H. Preece, for preparation of plans and specifications, examination of tenders, and general supervision of the works already sanctioned by the Vestry, be 5 per cent. upon the outlay of such works. The committee also recommended that the remuneration of Mr. Preece for performing the above duties in connection with all future works which may be sanctioned by the Vestry be 4 per cent. on the outlay of such works. This proposal was, however, referred back for further consideration.

Burnley.—The Gas Committee of the Town Council recommended at a meeting of the latter this week that in future the charges for electricity be reduced from 6d. to 5d. per unit for lighting purposes, and 4d. to 3d. for other purposes. Alderman Collinge said the profit for last year on an income of £2,215 was over £100. They expected the reduction would create such an extra demand as to keep the profit as much as before. The reduction was agreed to, and it was decided to seek powers to borrow £3,000 for additional machinery at the electric lighting stations, and £2,500 for extensions of the mains.

Medical Electrical Institution, Limited.—This Company was before Mr. Justice North on Saturday on a motion for judgment in an action brought by debenture-holders. It appears that £2,890 worth of first debentures had been issued, which became due on the company becoming insolvent or a distress being issued. Both these events had happened, the landlord of the Company's premises having issued a distress for rent. A receiver had been appointed, and the distress paid out. This was a motion for judgment in default of defence. His lordship made the usual order, and directed the sale of the property.

Wigan.—The Tramways Committee of the Corporation have received a communication from the Sandycroft Foundry and Engine Works Company as to the new system of electric conduit for tramways. At the same meeting the town clerk submitted the draft agreement for lease of tramways to Platt Bridge. It was decided that, subject to the contractors and the tramways company giving a guarantee for the performance by the company of the conditions of the lease, the draft agreement be approved, and that the Finance Committee be recommended to raise £20,000 for the purpose of the tramways undertaking.

Bournemouth.—The electric light company announce a reduction of 1d. per unit—that is, from 8d. to 7d.—the reduction to commence after March 30; also to furnish to the consumer the "Wright" indicator, and with this in use, under certain conditions, the price per unit will be reduced to 5d. The sliding scale of discounts heretofore conceded and calculated upon the gross annual consumption will be abolished, and the "Wright" system applied to those consumers who may desire it, 5d. per Board of Trade unit being charged for all current consumed in excess of 300 hours' use per half-year of the maximum current taken as shown by a maximum demand indicator.

Edison and Swan United.—The directors have resolved to pay on account of the dividend of the current year at the rate of 5 per cent. per annum, less income tax, on the "A" shares of the Company for the half-year ended December 31, 1894. This will work out as follows: on the 89,261 ordinary shares, £3 paid, 1s. 6d. per share; on the 5,000 shares, £5 paid, allotted to the Edison Electric Light Company, Limited, 2s. 6d. per share; on the 12,139 shares, £5 paid, allotted to the Swan United Electric Light Company, Limited, 2s. 6d. per share; all less income tax. The payment will be made upon the register as it stood on the 5th inst., and the dividend warrants will be issued on the 20th idem.

Kingston-on-Thames.—As mentioned in our last issue, Major-General Crozier held an enquiry last week respecting the proposal of the Town Council to borrow £10,000 for an extension of electric lighting. There were present Councillor Collings (chairman of the Lighting Committee), the town clerk, the borough surveyor, Mr. Preece (the consulting electrical engineer), and Mr. J. Edgcome (borough electrical engineer). Councillor Collings stated that the Corporation installed the electric light in 1893, and it had since been in operation with steadily increasing success. It was soon found that with the great demands for current, it would be necessary to add to the plant and mains originally contemplated.

Dundee.—A new engine and dynamo have just been laid down at the central station. The engine is 200 h.p., and the dynamo is coupled direct. There are now seven engines and seven dynamos at the station. The number of consumers of the current continues to increase, and it is expected that further additions to the plant will have to be made before next winter. It was reported to the Gas Committee of the Town Council on Tuesday that frequent bursts had taken place in the iron pipes at the electric station, and it was recommended that brass pipes should be substituted at a cost of £40. 10s. The meeting recommended the Council to agree to the proposed substitution, and to accept the offer of Messrs. Whyte and Cooper.

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Kensington, W.—The Works Committee reported to the Vestry last week that they had had before them a letter from the House-to-House Electric Light Supply Company asking the Vestry to approve of a plan submitted by them for the extension of their mains in Kensington High-street, Allen-street, and Abingdon-villas. The plan showed the construction of transformer-boxes under the public way, and the committee recommended that permission should be given for the works being proceeded with. The Vestry adopted a further report of the Works Committee recommending that permission be given for certain works to be carried out by the Notting Hill Company in Holland-park.

Islington, N.—The Vestry having considered a report from the electrical engineer (Mr. A. Gay), calling attention to the fact that electric lighting enterprise is being prejudiced by the explosions of gas occurring from time to time in conduits, and to the possible danger to life resulting from such explosions, recommends that a memorial be presented to the Board of Trade urging that steps should be taken by legislation or otherwise to obtain greater control over the gas companies as regards any escape of gas from their mains, and that a copy of such memorial should be forwarded to the other metropolitan vestries and district boards, and to the several metropolitan electric lighting authorities, with a request that they will make similar representations.

General Electric Tramways Company, Limited.—This Company has been registered with a capital of £50,000 in £1 shares. The object is to acquire tramways and tramway concessions for the construction of tramways or tramway plant, and to carry on business as tramway proprietors, electrical and mechanical engineers, and in particular to acquire certain interests in tramways at Hartlepool and West Hartlepool, county Durham. The signatories are Sir D. Ccoper, 6, De Vere-gardens, W.; Mr. J. W. Barclay, 54, Lansdowne-place, W.; Mr. P. E. Beachcroft, 10, Upper Hamilton-terrace, N.W.; Sir H. C. Mance, K.B., C.I.E., Manoro, Bedford; Mr. I. I. Courtenay, Temple, E.C.; Sir J. Pender, J.P., Rugby; and Mr. A. B. Blackburn, M.I.C.E., Bushbury Works, Wolverhampton.

South Westmoreland.—The Rural District Council have had an interview with Mr. Morse, who represented the Windermere Electricity Supply Company. Mr. Morse, in reply to the chairman, said he did not know that there were any special points in the application upon which he wished to make remarks. Two points had been raised when the application came before the Council, one of which he believed was that the area proposed by the company should be curtailed. The area had been marked as required by the Board of Trade, and he hoped it would meet with the approval of the Council. It would extend from Burton-in-Kendal on the south to a point indicated north of Kendal, and across in a westerly direction. All he asked was that the Council should approve of the application to the Board of Trade for the portion of the district defined. It was unanimously agreed to consent to the application.

Hobart Electric Tramway Company. — An extraordinary general meeting will be held at College-hill-chambers, College-hill, London, E.C., on Wednesday, the 13th inst., at 2 p.m., when the following resolution will be proposed: "That, inasmuch as the amounts of the £30,000 first mortgage debentures and the £15,000 second mortgage debentures issued by the Company are together equal to the nominal amount of the share capital of the Company issued, the directors be and they are hereby authorised, pursuant to Article 194 of the articles of association of the Company, to create and issue £5,000 further mortgage debentures ranking, *pari passu*, with the existing second mortgage debentures of the Company, or subject thereto, and to the first debentures of the Company as the directors think fit." A meeting of the holders of the second mortgage debentures of the Company will also be held on the 13th inst. at 2.20 p.m.

Leicester.—The Electric Lighting Sub-Committee of the Corporation had submitted to them on Friday by Mr. Colson, the gas and electrical engineer, his official report upon the explosion that occurred recently in the Market-street transformer-chamber near the Granville Hotel. Mr. Colson, who made an inspection of the chamber within a few minutes of the accident, states that in his judgment the explosion was caused by an electric arc being formed between the terminals in the high-pressure junction-box, and the consequent gasifying of the oil used in the box as the insulating medium. Owing to the explosion it has been decided to substitute specially prepared wax for the oil at present in use in the various transformer-chambers in the town. Mr. Colson is confident that coal gas had nothing whatever to do with the explosion. The Board of Guardians have decided to again invite tenders for fixing up a telephone.

Cheltenham.—The Electric Lighting Committee of the Town Council have had presented to them the monthly report of the borough engineer. The further consideration of suggested extension of the mains was adjourned. The committee had considered a resolution of the Public Library Committee stating that an error had been made in estimating £57. 18s. as the cost of the gas supply for the past year, the average cost for four years having been only £41. 16s. 6d., and that under these circumstances only £40 could be paid for the electric light. It was resolved to accept the offer of the Library Committee, subject to the installation being to the satisfaction and under the control and superintendence of the electrical engineer. Mr. Norman, chairman of the Electric Lighting Committee, has no doubt that during the ensuing month the electric light will be turned on by the contractors, who will run the station on their own responsibility for four weeks. By the middle of April the station will be in the possession of the Corporation.

Bangor.—Acting upon a suggestion made by an inspector of the Local Government Board, the Water and Gas Committee of the Town Council recommended on Wednesday that the borrowing powers of the Council be increased by £10,000 instead of £2,500, a large proportion of which is required for gas purposes. Dr. Grey Edwards asked whether the time had not come when the Council should consider the advisability of spending the money in question upon electric lighting. He was afraid that if £10,000 was now secured for improving the gasworks, electric lighting at Bangor would be thrown back a generation. He moved that the Water and Gas Committee be instructed to report upon the expediency and cost of providing electric lighting before proceeding to expend any large amount on the gasworks, and report to the next meeting. Mr. Robert Hughes seconded the motion. Both the recommendation of the committee and the resolution proposed by Dr. Edwards were adopted.

The Rhondda.—The Urban District Council for Ystradyfodwg received on Friday a deputation from the Rhondda Valley Chamber of Trade with reference to the proposal to light the public buildings and the streets of the Rhondda with electric light. One of the deputation complained that they were being very badly treated by the Ystrad Gas and Water Company. Another of the deputation said the Chamber had decided to offer a premium of £50 for a scheme to light the valley with electricity, but as the Council had taken the matter up they thought it advisable to approach them before taking any steps. If the scheme was carried out to a successful issue to light the streets, the deputation asked if the Council would also supply the business houses with electric light, as they now had to pay 4s. 3d. per 1,000ft. for gas of a poor quality. The Chairman (Mr. W. Jenkin, J.P.) assured the deputation that the Council were still continuing their investigation into the matter, and that they might rely upon the Board making every effort to supply them with the light if the scheme was successful.

Mersey Railway.—It was stated by the chairman at a meeting on Wednesday of the Mersey Railway Company that in the annual report it was mentioned that the subject of working the railway by electricity was still receiving the consideration of the directors, and "that they hoped by the date of the annual meeting to report further on the matter." From letters which he had received it was evident that there was a wide-spread belief that the directors had absolutely determined to employ electricity as a means of motive power, but that was not so. Some members of the Board were very strongly in favour of it, and they had been making exhaustive enquiries as to the probable outlay and the probable results. They had that day received a report from two eminent engineers upon the matter. Personally he was neither in favour of it nor against it. If it could be shown to him that the working expenses could be materially lessened by electricity, then he might consider it wise to adopt it, but until that was made clear he should not recommend the shareholders to enter upon experiments of so extensive a character.

Lighting of Printing Works.—The new printing works of the Geraldine Press, 21, Whitefriars-street, E.C., and the block of offices belonging to *Answers*, Limited, in Tudor-street, E.C., are now lighted throughout by electricity. Mr. E. R. Dolby, A.M.I.C.E., of 8, Princes-street, Westminster, acted as consulting engineer for the proprietors. The current is produced in the basement of the works of the Geraldine Press by a compound-wound direct-current dynamo, made by Messrs. Crompton and Co, and driven direct by an engine made by Messrs. Belliss and Co., of Birmingham. About 190 lamps have been installed in the works and about 80 lamps in Tudor-street, and the lighting of both premises is controlled from one switchboard fixed close to the dynamo. The large Hoe machine used for printing *Answers* and the Marinoni machines used for printing the other papers published at the same offices are lighted up internally by incandescent lamps, which much facilitate the work. The wiring of the buildings was carried out by the Electrical and General Engineering Company, of 86, Leadenhall-street, E.C., under the supervision of the consulting engineer.

Bath.—Major Cardew held an enquiry on Wednesday into the applications for provisional orders under the Electric Lighting Acts. The original applicants were the electric lighting company, for whom Mr. Morse appeared, with Sir Frederick Bramwell as an expert witness. The local authority would not consent to the application, and made a competitive one, being represented by Mr. MacMorran and Mr. W. A. Jolly. The case of the company was first heard. It was explained that the electric light was introduced in Bath by Mr. Massingham in 1890, who had a license which would expire at the end of 1897. In 1891 Mr. Massingham transferred the business to the company which now sought the order, with power to light the whole city instead of a restricted area. It was said that £40,000 had been spent in the undertaking, and that £15,000 would provide for the contemplated development. Sir Frederick Bramwell was examined as to the suitability of the town weirs and the destructor for generating purposes, as the Corporation contemplate using them, and gave it as his opinion that they are valueless. For the authority it was stated that they were dissatisfied with the company's supply, and wished to have the control of the light in their own hands.

The City.—At a meeting of the City Commission of Sewers on Tuesday, Mr. Berridge, in answer to Mr. Wallace, said that no report had been presented by his committee on the subject of the use of telephone tubes because some delay had occurred on the question as to the legality of the Commission taking any part of the rental of the telephone tubes, and counsel's opinion was now being taken. When that was received the committee would probably bring up a report. Mr. C. T. Harris said that was

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exactly what he had predicted. He did not think the Commission had any right to take a rental. The Chairman wished to draw the attention of the Court to a report by Major Cardew on the subject of explosions in transformer stations. That gentleman had explained that the explosions were caused by a deposit of sodium, and that the metal sodium came in contact with the wet and caused an explosion. He wished to ask the electrical inspector whether he had had any experience of that kind in the boxes in the City. Inspector Voysey said with regard to the sodium found in the boxes in St. Pancras it had been formed by the current passing through the bare metal conductors resting on the insulators. In the City, however, there were no bare metal conductors or stoneware insulators.

Aberdeen.—The Gas and Electric Lighting Committee of the Town Council have recommended the acceptance of the offer of Messrs. Scott and Sellar, of Aberdeen, to extend the distributing mains and erect the portion of the engine block at the electric lighting station in the same manner and at the same rates as in their original contract. Sir George Trevelyan has sanctioned the raising by the Town Council of £5,000 for the execution of works under the Aberdeen Electric Lighting Order, 1890, being the balance of the loan of £25,000 sanctioned by the Council in 1893. The Town Council have decided, consequent upon the appointment of a Parliamentary Committee with reference to the question of the control of the telephone system, to join with other corporations in giving evidence on this question before the committee. For the appointment of electrical engineer, the Electric Lighting Committee recommended, a few days ago, the names of Messrs. A. S. Blackman, Aberdeen; John Christie, Londonderry; W. H. Tittensor, Dundee; and John Williamson, London. Mr. Johnston, convener of the committee, proposed Mr. A. S. Blackman for the appointment, who, he said, was in the service in the meantime, and he might say that Mr. Blackman had given the utmost satisfaction. Bailie Mearns seconded, and, on a division, Mr. Blackman was declared elected.

Tunbridge Wells.—The question of providing the Town Hall with the electric light came up for consideration at a meeting of the Town Council on Wednesday. It was said that £300 would be needed for the purpose, and to this outlay on the municipal buildings several members objected. The Mayor, speaking from his own experience, suggested that the matter of the Town Hall installation should not be hurried. First of all, let the Council develop the electric light as much as possible, and so get a source of income from the public. They themselves could afford to wait. He should suggest that the Council-chamber part of the Town Hall be not fitted up with the electric light, as it was not needed there. Councillor Wilmott said the argument worked two ways. When they said "supply the town with the new light as much as possible, but don't put it in the Town Hall," it seemed like the doctors who recommended medicine they themselves would not take. Councillor Wilmott quite agreed that they need not spend so large a sum as £300 on the Town Hall, but suggested a lesser sum as an experiment to show town customers that the Corporation could themselves use the class of light they recommended. The recommendations of the Lighting Committee were in part endorsed, but another report fully dealing with the details of the new lighting proposals as regards the municipal buildings is to be laid before the Council at a future meeting, and before any sum is voted for the purpose.

Electric Traction.—The chairman of the Barcelona Tramways Company mentioned to the shareholders at a meeting on Wednesday that there was a paragraph in the report of very great importance. It was as follows: "Your directors having become aware of the advantages, both to the companies and to the public, to be derived from the substitution of electric for animal traction are taking steps towards obtaining powers to adopt it, and during the interval which must inevitably intervene before finally obtaining the necessary permission they are diligently enquiring into the respective merits of the various systems now in use." He said that they would observe that that paragraph was carefully worded. They had studied with great attention the electric system; they had seen it at work abroad, and were convinced that the adoption of it would be of great advantage. At the same time, before actually embarking on that they must take care that the conditions under which they worked would not be made in any way onerous to them. They had one or, rather, two conditions which were sources of satisfaction as far as that company was concerned. First, they had an immense area to work upon—between 17 and 18 miles—and if they could save a large percentage in the working expenses, they were safe in adopting the system. The second consideration was that, as their fares were most moderate, there was little danger that they should suffer by being obliged to reduce them, assuming that they were able to work with better advantages.

Brighton.—The Town Council had before them yesterday the statement of accounts of the Corporation electric lighting undertaking for the year 1894. The capital invested in this undertaking is now over £120,000. The total receipts on revenue account for 1894 were £16,378, and the expenditure £6,490, leaving a balance (after providing for bad debts) of £9,800 gross profit. Against this and a balance of £300 brought forward from the last account have to be charged the interest on the redeemable stock debt, and the appropriations for the sinking fund, amounting together to £5,014, leaving a balance of £5,086 for net profit. Out of this the committee propose to make the payments for adjustment of old accounts, to set aside £3,000 to a reserve fund, and pay over £1,120 in aid of the rates. A report from Mr. Wright, the engineer of the electricity works, gives valuable information as to the working cost of the electric light station. He once more points out the importance of encouraging consumers to use electricity at times when the demand is not at its heaviest, as during those hours the costly plant is lying comparatively idle. It was with the view of affording such an inducement that the sliding scale, charging 7d. per unit for an average of two hours' working per lamp per day, and 3½d. per unit beyond that average was fixed. The committee now propose to give further encouragement in the same direction by making the lower charge 3d. per unit instead of 3½d., and to make the limit of the 7d. charge an average of one hour, instead of two, per lamp per day. They also recommend that the meter rent be reduced from 5s. to 2s. 6d. per quarter. Mr. Wright suggests that all meter rents should be abolished except to customers using less than one hour's light per lamp per day. The committee propose to recognise Mr. Wright's services in connection with the undertaking by offering him an increase of salary, from £400 to £600.

Leeds Tramways.—The Corporation Tramways Bill came before the Standing Orders Committee of the House of Lords on Thursday on the question of whether the standing orders should be dispensed with. There were present the Mayor and Town Clerk of Leeds, Alderman Ward, Alderman Firth, Councillor Battle, Councillor Wilson, and Mr. Hewson, city engineer. Mr. Hewson produced plans of the proposed generating stations, and explained them to the committee. The committee decided to dispense with the standing orders as regards the revival of powers for the construction of tramways, but declined to do so as regards the generating stations, the chairman observing that no doubt there might be found some means of getting round the question. After the promoters had left the House, Lord Morley sent a messenger to the office of the parliamentary agents with a request to see Mr. Pritchard. On that gentleman attending, his Lordship informed him that he had reconsidered the matter, and that, considering the importance of fixing the generating stations, he would allow an amended clause fixing the stations as they appeared upon the plan submitted by the city engineer. That being so, the Bill will now be reported as having complied with the standing orders. The only point now remaining for settlement has reference to granting power to the Corporation to work the tramways. At a meeting of the Town Council on Wednesday, Alderman Spark said the Corporation, according to the Bill, were asking for power to produce electricity. It seemed to him that if they got such power it would not be competent for the Council to discuss the question of haulage. Mr. Battle replied that the power was permissive, and not obligatory. The whole question of haulage must be discussed by the Council, but it would have been foolish when they were going for powers not to have asked sanction for electrical haulage. The Town Clerk confirmed what Mr. Battle had stated. There would, he said, be no obligation resting upon the Corporation to put down an electric power station in the event of parliamentary consent being given. The power had been asked for in order to comply with the standing order, which said that certain things, including the use of electric power, should not be used without consent. The Council would not be prejudiced in the least as between electric and cable haulage by powers being received to put down an electric power station.

Monmouth.—A special meeting of the Town Council was held last Friday to meet Mr. Harris, of Messrs. Bramwell and Harris, the engineers for the electric lighting part of the Corporation's combined drainage and electric lighting scheme, and Mr. Lailey, the engineer for the drainage section of the scheme. Major Lister, the Duke of Beaufort's agent, was present. The Mayor, Mr. W. Honeyfield, who presided, observed that it was a special meeting called to consult with the engineers on the completion of their plans for the combined drainage and electric lighting scheme. Before, however, they went into that matter, Major Lister was present and would answer any questions they would like to ask with reference to the proposed site for works on the Monnow at the Forge. If the Corporation would consider that matter first, they would then be able to set Major Lister at liberty. The Mayor, addressing Major Lister, asked whether in the event of the Corporation wanting water power at the Old Forge, he was prepared to let the Corporation have a 99 years' lease. Major Lister replied that on the terms of £50 for the use of water power, he would be prepared to grant the Corporation a 99 years' lease. The extent of the site was then considered by means of the plans, and after some conversation with the Mayor and members, Major Lister withdrew. The Council then resolved itself into committee to consider the scheme, as it had developed, with the engineers. The Town Council on Monday considered the plans for a combined scheme for drainage and electric light, prepared by Messrs. Bramwell and Harris, C.E., and Mr. Lailey, C.E., London. The Council discussed the plans in conjunction with the engineers in committee on February 22, and an addition of about £4,000 to the cost of the scheme was proposed, owing to additional details in the drainage of the streets of the town (Mr. Lailey's portion of the work), which would raise the original estimated cost of £18,000 to £22,000. Mr. Cossens proposed that that portion of the scheme which related to the electric light be relinquished, and that the Local Government Board be approached again for permission to drain into the Wye by gravitation. This was seconded and supported by several members. Mr. W. C. A. Williams intimated that the law would not permit the pollution of the Wye. The Mayor stated that they would effect a saving of 5d. in the £ to the rates by the earnings of the electric light. He showed that drainage alone would cost about 1s. in the £ for the next 30 years, whereas the combined scheme would reduce that sum to 7d., and at the end of the 30 years the Corporation would have plant producing about £600 per annum to be devoted

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to the reduction of the rates. Messrs. Bramwell and Harris had now offered to take over that part of the scheme entrusted to Mr. Lailey and carry out the whole work at the original cost of £18,000. Mr. Cossens withdrew his proposition, and it was decided to accept the plans of Messrs. Bramwell and Harris.

Worcester.—The question of "extras" has come before the Electricity Committee of the Corporation. It appears that the committee have passed a resolution that the city engineer should be instructed not to sign any further certificates or other documents in connection with Mr. Rowbotham's contract for the electricity generating station. The committee have presented a detailed report by the sub-committee upon the "extras" payable, amounting to upwards of £4,400. Since investigating the above the committee have received another claim from the contractor for £1,068 for damages to his works through flood. The City Council a few days ago discussed the question of the £5,000 extras in connection with the electric light works. Mr. Williamson (chairman of the committee) said that the first thing which struck the committee was the systematic way in which the estimates had been wrong from beginning to end. He called particular attention to the charge of £1,450 for carting soil at the works beyond the 100 yards boundary, and added that the committee were not aware of the extra work being carried out. It appeared that the Corporation would have to pay for the work because the quantity surveyor had measured it and the surveyor had certified it. The surveyor had directed work without consulting the committee. He moved the adoption of the committee's report. Mr. Millington, who seconded, said that the original estimate for the electricity scheme in 1892 was £29,000, and now the expenditure was nearly £60,000. The Sheriff (Mr. Mathews) raised the question as to the Council's liability to pay the money. He said he thought under the terms of the specification that the contractor should have the written instruction of the engineer before undertaking extra work, and it appeared there was no written instruction. He therefore moved that the matter be referred back to the committee for reconsideration. Mr. Cook seconded. In answer to a member, the Town Clerk said that if the Council were going to fight the question it was not advisable that he should express any opinion as to the liability of the Council. Several members urged that the amendment should not be then put, as it would prevent any further debate, and up to that stage only one side had been heard. The amendment was, however, submitted, and carried by 21 votes to 15. The chairman of the County Council, in submitting to the latter last week a statement of the facts in connection with the contract for the installation of the electric light at the Shire Hall, explained that he went through and settled the draft contracts, which after some negotiations were agreed to by the parties. A contract with Messrs. Verity and Son for £91. 3s. 11d. was sealed at the last meeting, and that with the New British Electric Installation Contractors for £474. 6s. 6d. now came before the Council for an order for sealing. The report was adopted, and it was agreed that the opinion of an electrical expert as to whether the fittings, etc., had been properly carried out, should be taken before anything further was done in the matter.

Derby.—The Electric Lighting Committee of the Town Council have reported that they have had presented to them the accounts of Messrs. Siemens Bros., certified by the engineers, Messrs. Bramwell and Harris. The expenditure granted was £35,000. The committee have actually expended £34,000, and have incurred liabilities amounting to £9,000, making a total of £43,000, being £8,000 in excess of the amount granted. Messrs. Bramwell and Harris have made reports to the committee accounting for this extra expenditure, from which the following are extracts:—"Contract No. 1: Boilers.—Let to Messrs. G. Fletcher and Co., of Derby. The amount of this contract was £1,960; actual amount paid, £2,171, the excess being £211, which is accounted for by additions to coal elevator, stores, and renewals of parts of mechanical stokers, interest, extra chequer plates, and manhole cover, etc. Contract No. 2: For machinery.—Let to Messrs. Siemens Bros. and Co., Limited. The amount of this contract was £13,119; actual amount paid, £13,574, the excess being £450, which is accounted for by the purchase of spare gear, fire insurance, extra gearing, and safety precaution on switchboard required by the Board of Trade. Contract No. 3: Building Station, etc.—Let to Mr. Hy. Vernon, of Derby. Amount of contract, £6,464; actual amount paid, £6,868, the excess being £400. The excess is accounted for by fire insurance premiums, interest on retention money, covering the mill race adjoining engine-house, and small extras which arose during the contract, including laying extra depth of concrete in foundations. Contract No. 4: Mains.—Let to Messrs. Siemens Bros. Attention should be directed to the fact that this contract is for materials supplied and work done on a schedule of prices, and not for a lump sum. It is in this contract that the largest increased expenditure occurs, which cannot be regarded as 'extra,' inasmuch as it is for work and materials beyond what was originally contemplated." A table is appended to the report illustrating the increase in this contract. When the original estimate was prepared, it was contemplated that a period of two years would elapse from the date of opening before the largest output would be realised, but, as a matter of fact, this period arrived at the end of 15 months. From this table it appears that the greater portion of the extra expenditure was owing to the abnormally rapid and unexpected increase of the rate at which the public has taken the light, and the original estimate provided for a station with a capacity of 7,500 8-c.p. lamps for private lighting, and 45 public arc lamps lighting 2¼ miles length of streets, whereas the actual capacity of the station now is 15,000 8-c.p. lamps, and 77 public arc lamps lighting 4½ miles of streets. The following expenditure has been incurred irrespective of the above-named contracts: covering steam-pipes, £134. 11s. 8d.; meters, etc., £556. 11s. 8d. There are at present 10,012 lamps on the private supply, and a further 2,000 are ready to be connected. By October next (the end of the two years originally contemplated) the total present capacity of the station will be absorbed. In addition to the above analysis, the committee have personally gone through the accounts of Messrs. Siemens on Contract No. 4, and give the items which make up the extra expenditure, £7,868. Messrs. Bramwell and Harris have also advised the further expenditure of £5,000, made up as under: alteration of premises adjoining station, £1,000; additional distributing and connecting mains, £2,000; three additional boilers, £2,000. This question has been considered by the committee, and a resolution has been passed recommending the Council to incur this additional expenditure. The committee asked the Council at their meeting on Wednesday to approve the expenditure of £8,000 over and above the amount already voted, and also to vote a further sum of £5,000 as above stated, the money to be borrowed with the sanction of the Local Government Board. The expenditure was sanctioned.

Birmingham.—The City Council on Tuesday had brought before them by Mr. Martineau a motion, which was referred to in our last issue, that the Technical School Committee be authorised to expend £6,080 in providing electric light fittings and motive power at the new technical school, and that the Finance Committee be instructed to borrow that amount. He said they found there was an increasing use of electric motors as a power. With the application of electricity for power, it was also found convenient to have it for lighting as well. That was effected by having the machinery larger, which would conduce to the efficiency of the lighting and to the economy of the power. Thus, while it appeared from the figures that incandescent gas was a little lower in price, they recommended the adoption of electricity, because it would be more convenient, and the installation of the electrical plant on their own premises would be one of the best possible means for a practical education in the science of electricity. Alderman Kenrick, M.P., seconded. Alderman Pollack said he did not oppose the motion, and recognised the fairness of the report, but he differed from the committee as to the conclusions to be deduced from the figures. Mr. Bradley moved an amendment similar in terms to the one he moved at the last meeting of the Council—viz., "That with regard to the proposed electrical installation, the committee be instructed to accept the lowest tender submitted on the specification originally issued to a selected number of firms." He said he thought the committee had scarcely acted justly or wisely in the course they had adopted, and the importance of the principle which was at stake was much greater even than a slight difference between the tender now recommended for acceptance by the committee and the lowest tender received under the original specifications. He was afraid that if the Council sanctioned the course of procedure adopted by the committee the Corporation would sustain serious injury in finding firms of any standing and repute very reluctant to submit tenders to them. Messrs. Fowler and Lancaster tendered to do the work for £6,271, and then in November they saw a paragraph in the papers that a sub-committee of the Technical School Committee would recommend that the contract be given to another firm, outside Birmingham, at a higher price. He had letters from Dr. Hopkinson, who designed the Manchester Town Hall lighting, and from Mr. Preece, the Post Office engineer, speaking to the qualifications of Messrs. Fowler and Lancaster to carry out the contract. But the mind of the committee evidently was to pay more than was needful to take Birmingham work out of the town. Having rejected the tender in question, the committee threw over altogether the tenders received from the selected firms, and threw the contract open for general competition, the specifications being revised for this purpose. Supposing that revision was necessary, and not merely specious, should the specifications not have been submitted in their revised form to the firms who had originally tendered, and not to the whole kingdom? He maintained that they should, and that the course adopted was unjust to the firms first selected. Mr. Bishop seconded the amendment. Mr. Martineau said the whole of the firms which tendered under the first specifications also tendered under the revised specifications. The committee most carefully investigated the whole matter, and they saw reasons which to them were absolutely unimpeachable for the recommendation with which they now came before the Council. A division was then taken, Mr. Martineau intimating that the committee would regard it as a vote of confidence. The voting was 30 for the amendment and 28 against. Mr. Martineau said that he was going to say before, when he was not allowed to proceed, that circumstances had come to the knowledge of the committee which they could not state to the Council. If the confidence of the Council was not placed in them sufficiently to believe that they had reason for the course they had taken, they wished the Council to place the functions entrusted to them in other hands, and forthwith the committee would unanimously resign. A show of hands was taken upon the amendment as a substantive resolution, but there being a general demand for names, the latter were taken. At the conclusion of the voting, the Mayor said as a substantive motion, there were 32 for and 34 against. Alderman Clayton said that the Council decided that they preferred the amendment to the resolution, but that they would not confirm the amendment when it was put as a resolution. The resolution of the committee was dead with the first vote, therefore they must go to the next business. The Town Clerk endorsed what Alderman Clayton said. So far as concerned the resolution before the Council with reference to the electric lighting, the proceedings were at an end. The original proposition had not been carried; the amendment had been carried, but

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not carried as a substantive resolution, therefore the whole matter was at an end so far as that resolution was concerned. It was open for the chairman of the committee to proceed with the rest of the business. Mr. Martineau then submitted resolutions recommending the purchase of apparatus and appliances for the technical school at a cost of £4,000, and the expenditure of £3,340 for architects' fees, electrical engineers' commission, and clerk of the works' salary in connection with the school, and concluded by moving the approval of the report, with the exception of that part connected with the electric lighting. Mr. Hughes seconded the resolution, which was agreed to.

PROVISIONAL PATENTS, 1895.

FEBRUARY 25.

4019. **An improvement in electric apparatus for engine-room signalling and like purposes.** Sidney Marow Eardley-Wilmot, Walter Thomas Wright Thackeray, Sydney Hoare, and Keith Ronald Mackenzie, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4038. **Improvements in or relating to telegraphic apparatus, applicable for use in ships or other purposes.** James Bain Irvine and George Foulkes, 6, Lord-street, Liverpool.

FEBRUARY 26.

4065. **Improvements in electric tramways and apparatus connected therewith.** Sebastian Ziani de Ferranti, 27, Charterhouse-square, London.

4085. **A device for switching off the current from an incandescent electric lamp by a movement of the lamp itself, without its removal from the holder.** Wilford Wyatt Martin, Worcester Cross, Kidderminster.

4106. **Dynamo-electric generators and motors.** Arthur Edwin Lones, High-street, Princes End, near Tipton, Staffs. (Complete specification.)

4111. **Improvements in electric insulators.** George F. Chutter, Constitution-hill, Birmingham.

4119. **Improvements in electric contact strips.** Charles Méray-Horvath, 70, Market-street, Manchester. (Complete specification.)

4120. **Electric heaters for applying artificial heat to the human body and also for the purpose of artificially heating apartments, cars, furniture, and such like.** John Emory Meek, 70, Wellington-street, Glasgow. (Complete specification.)

4153. **Method of and apparatus for insulating electrical conductors.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Louis Welton Downes, United States.) (Complete specification.)

4154. **Improvements in apparatus for use in electro-deposition.** The Cowper-Coles Galvanising Syndicate, Limited, and Sherard Osborn Cowper-Coles, 47, Lincoln's-inn-fields, London..

4160. **Improvements in electric transformers or converters.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Thomson Electric Welding Company, United States.) (Complete specification.)

FEBRUARY 27.

4182. **Improvements in electrical furnaces and in regulating and working the same.** David Urquhart and Frank Wynne, 17, Victoria street, Westminster.

4215. **Improvements in electricity meters.** Hermann Herberts, 89, Chancery-lane, London.

4245. **Improvements in electrical galvanic batteries.** Giambattista Laura, 65, Chancery-lane, London. (Complete specification.)

4255. **A rheotone or novel apparatus whereby a battery of great internal resistance is rendered capable of generating an induction current in coils of low internal resistance.** Giambattista Laura, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4257. **Improvements in or connected with electric arc lamps.** William Phillips Thompson, 6, Lord-street, Liverpool. (Wilhelm August Rasmus Mathiesen, Germany.) (Complete specification.)

4260. **Improvements in electric apparatus for indicating or recording at a distance the position or motion of a primary mechanism.** Alphons Custodis, 433, Strand, London. (Complete specification.)

FEBRUARY 28.

4303. **Electric signalling arrangement for locks and the like.** Hugo Nöhmer, 10, Friedrichstrasse, Berlin.

4323. **Improvements in cases for accumulator batteries.** Walter Claude Johnson, 28, Southampton-buildings, Chancery-lane, London.

4330. **Improvements in electric arc lamps.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Suddeutscher Rödrendampfkesselbau Simonis and Lang, Germany.)

4352. **Improvements in dynamo-electric machines and motors.** Llewellyn Birchall Atkinson, 1, Queen Victoria-street, London.

4357. **An improved electrical apparatus for reproducing images of distant objects.** Robert Berglund, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MARCH 1.

4426. **Improvements in incandescent electric lamps.** Julius Wende, 70, Chancery-lane, London.

MARCH 2.

4458. **Improvements in or relating to apparatus for electrically steering ships.** Frederick Adolphus Langen, 3, St. Nicholas-buildings, Newcastle-on-Tyne. (Complete specification.)

4490. **Improvements in dynamo-electrical machines.** Sebastian Ziani de Ferranti, 27, Charterhouse-square, London.

4497. **Automatic current-permutating device for electro-magnets.** Oscar von Morstein, 89, Chancery-lane, London. (Complete specification.)

4499. **Improvements in or relating to electric indicating apparatus.** Richard Myers, 323, High Holborn, London.

4525. **Improvements in electrically-operated stringed musical instruments.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William S. Reed, United States.)

SPECIFICATIONS PUBLISHED.

1894.

207. **Electrical transformers.** De Ferranti.

2437. **Electric time alarm and synchronising apparatus.** Cardoso e Bastos.

6888. **Telegraphic and telephonic apparatus.** Imray. (Société Anonyme pour la transmission de la force par l'Électricité.)

7054. **Electrically-propelled vehicles.** Clubbe and Southey.

7853. **Electro-deposition of metals.** Thoms and Burgum.

18480. **Electrical gaslighters.** Jaskey and Else.

20330. **Electromagnetic motor.** Vago.

24564. **Electro-locomotives.** Heys. (Heilmann.)

24583. **Electric car heaters.** Whittingham.

1895.

348. **Electric current rectifiers.** Close.

497. **Electric railways.** Love.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5⅝
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2¼-2⅝
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5-5¼
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	15-15½
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	130-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	3-3½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	102-107
Electric Construction, Limited	2	¼-½
—— 6 per cent. Debentures	—	96-97
—— 7 per cent. Cumulative Pref.	2	1½-1¾
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅜-1⅝
Elmore's French Company	2	—
Elmore's Wire Company	2	1¼-1⅜
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	10-11
—— Preference	—	12
House-to-House Company, Ordinary	5	3½-3¾
—— 7 per cent. Preference	5	7¼-7½
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge	5	7-7¼
—— 6 per cent. Pref.	5	7-7¼
Liverpool Electric Supply, Ordinary	5	7 5/16-7 7/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8¼-8⅜
—— Pref.	10	13-13½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	½-¾
Metropolitan Electric Supply	10	10¾-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5¼-5½
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	14¼-15½
—— 5 per cent. Nom. Cum. Third Pref.	5	5½-6
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7½-7¾
Oriental and Electric Company, £1 shares	1	9/16-11/16
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5⅜-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅞-8
—— 7 per cent. Pref.	5	8¾-9
Swan United	—	—
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7¼-8
Yorkshire House-to-House	5	4¼-4¾

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NOTES.

Society of Arts.—On Monday next, at 8 p.m., the first Cantor lecture on "Commercial Fibres" will be delivered by Dr. D. Morris, C.M.G.

Fire.—A telegram from New York states that the establishment of Mr. Nikola Tesla in that city was destroyed by fire on Wednesday morning. The damage is estimated at £20,000.

Institution of Civil Engineers.—If time permits, a paper by Mr. Henry Davey, M.I.C.E., on "Steam-Engine Economy: Condensing Engines," will be read at the meeting on Tuesday next.

British Association.—Sir Joseph Lister, Bart., foreign secretary of the Royal Society, will be nominated president of the British Association for the meeting which will be held at Liverpool in 1896.

Legislation in India.—It is stated that the Bill which provides for the electric lighting of the streets in Calcutta, Madras, Bombay, and Rangoon, will not be passed through the Council until the close of the present year.

James Forrest Lecture. — The James Forrest lecture of the Institution of Civil Engineers will be delivered, on May 2, by Prof. W. C. Unwin, F.R.S., M.I.C.E., and is intended to be a complete monograph on the history of experimental study of heat-engines.

Telephone Posts.—A correspondent asks an evening paper whether the National Telephone Company can show written permission for the erection of one post in 50, and whether the Postmaster-General will be advised to purchase without legal evidence of their right in regard to each post.

Cambridge University Local Examinations.—The exhibition of £30 per annum with a sizarship, offered by St. John's College, Cambridge, to the senior candidate standing first in pure and applied mathematics, has been gained by Mr. E. L. Watkin, Wellingborough Grammar School.

Railway Bills.—The House of Commons Committee of Selection have appointed a committee, Sir R. Paget, chairman, to meet on Wednesday next for consideration of the City and South London Railway; London, Walthamstow, and Epping Forest Railway; and Latimer-road and Acton Railway Bills.

Electrical Engineering in Europe.—The views of Mr. H. Ward Leonard, who recently visited this country, are set forth in a paper entitled, "Notes on Recent Electrical Engineering Developments in France and England," presented at a meeting of the American Institute of Electrical Engineers.

Duty Payable on the Unknown. — A *Times* correspondent states that the Canadian Customs Department has decided that electricity generated on the American side of the Niagara Falls and conducted by wires to the Canadian side must pay a duty of 20 per cent. as "an unenumerated article."

Electric Light Buoys.—The North German Lloyd steamer "Havel" was entering New York harbour in a fog on the 7th inst. when the pilot discovered that the ice had wrecked the electric lights on the buoys. He attempted to put back, but in doing so the vessel grounded. The vessel was floated on the following day.

Bordeaux Tramways.—The chairman of the Bordeaux Tramways Company told the shareholders on Wednesday that he thought the time was fast approaching when the shareholders must consider the question of adopting electricity for their tramways, and that he hoped to bring that matter forward at the next meeting.

Electrical Communication with Lighthouses.—A daily paper states that it is impossible at present to state when the Earl of Mount Edgcumbe's Commission on Electrical Communication with Lighthouses will finish their work, but it is scarcely probable that they will be able to do so before the close of the year.

Telephony and Military Operations.—It is stated that the military district of Kieff is shortly to be connected by telephone with the Odessa military district, Nicolaieff, and Sebastopol, and it is expected that all the chief military and naval points in South Russia will be joined by telephone before the end of the present year.

Students of the Institution.—A students' meeting of the Institution of Electrical Engineers will be held in the library of the Institution, 28, Victoria-street, on Friday next, the 22nd inst., at 8 p.m. The following paper will be read: "Lead-Covered Cables," by Mr. Mervyn O'Gorman (Fowler-Waring Cables Company).

Royal Meteorological Society.—An ordinary meeting of this society will be held at 25, Great George-street, Westminster, on Wednesday next, the 20th inst., at 7.30 p.m. A lecture, which will be illustrated by experiments, will be given by Mr. W. N. Shaw, F.R.S., on "The Motion of Clouds Considered with Reference to their Mode of Formation."

Cardiff Central Station.—We must sympathise with Mr. Massey and the contractors for the Cardiff central station. Complaints have frequently been made in regard to the arc lighting, and to a certain extent in the case of the incandescent lighting. It seems as if all the blame for the present position of affairs rests with the Lighting Committee of the Corporation.

Lecture.—A lecture on electric lighting was delivered on Friday by Mr. J. C. Howell before the Llanelly Chamber of Commerce. In the course of his address he said that where companies were properly managed electric lighting could be made to pay. He was extremely anxious that they should do the right thing from the start in Llanelly, and that could only be done by securing the services of an expert.

Ealing Central Station.—It was mentioned by Mr. Warner at the enquiry held last week at Bath, that at Ealing heat from the destructor was being used for the purposes of raising steam for electric light purposes. Mr. T. O. Callender, however, denied this. He said he was one of the contractors for that electric light installation, that he was there on Friday, and that the connecting flue had not been constructed.

The Albert Medal.—The council of the Society of Arts will consider the award of the Albert medal for 1895 early in May, and they, therefore, invite members of the society to forward to the secretary on or before the 13th of April the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit for promoting arts, manufactures, or commerce."

Telephony.—The National Telephone Company have issued an intimation in Edinburgh that arrangements have now been made with the Post Office whereby the company's subscribers will be able henceforth to communicate by means of the Post Office trunk wires between the following towns: Belfast, Birmingham, Bristol, Cardiff, Exeter, Glasgow, Leeds, Liverpool, Manchester, Newcastle, Newport, Plymouth, and Swansea.

Northern Society of Electrical Engineers.—The satisfactory position of this society is indicated by the report for the session 1893-94, and the statement of account

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for the year ended 1894. The report, which shows that the roll of the society comprises 122 members and three associates, is followed by a list of the names of the president, council, and officers for the current session, together with the rules and regulations of the society.

Guernsey Electric Tramway.—A correspondent writes to a Leeds paper stating that on this line the fare is 1d. for three miles, with special rates for workmen and school children. The working expenses, he says, are 5·791d. per car mile, but it must be borne in mind that coal and all other materials are more expensive in Guernsey in consequence of the long carriage. The actual running expenses—such as coal, oil, etc.—are less than 4d. per car mile.

Cable Rates to South Africa.—It is stated that the negotiations for the reduction of the cable rates to South Africa have now been completed, the Imperial Government, through the Treasury, having agreed to pay its share of the subsidy. The difficulty with respect to the traffic over the Portuguese territory on the East Coast has been arranged, as have the other obstacles which have arisen from time to time. The reduced rates will come into force in April.

The Proposed Pacific Cable.—The latest idea for the construction of a Pacific cable is contained in a New York telegram dated the 9th inst. The despatch states that a project is now under consideration whereby Russia, France, Japan, and Hawaii will join with an American company in constructing a telegraph cable from San Francisco to Hawaii, and thence to Japan and the French islands in the Pacific. The negotiations, it is reported, are almost concluded.

Chesterfield Institution of Engineers.—A special meeting of the Chesterfield and Midland Counties Institution of Engineers (Mr. William Spencer, president, in the chair) will be held in University College, Nottingham, to-morrow (Saturday), the 16th inst., at 2.30 p.m. The business includes the presentation of a paper on "Continuous-Current Dynamos and Motors: Choice of Plant, Fixing, and Driving, Usual Faults and their Remedies," by Mr. Lancelot W. de Grave.

Books Received.—We have received a copy of "Meteorology," by Mr. Thomas Russell, published by Messrs. Macmillan and Co., of London and New York; a copy of "The Telegraphists' Guide to the New Examinations in Technical Telegraphy," by Mr. James Bell, A.I.E.E., issued from the offices of *Electricity*, 29, Ludgate-hill, E.C.; and a copy of "Street Railway Investments," by Mr. Edward E. Higgins," published by the Street Railway Publishing Company, New York.

Electric Construction Company's Works.—A reprint has been issued in pamphlet form of an article which appeared in the *Machinery Market* descriptive of the Bushbury works of the Electric Construction Company at Wolverhampton. Besides giving a historical sketch of the company and descriptions of the works and important undertakings carried out by them, the pamphlet contains illustrations of the works and information concerning the leading specialities made by the company.

Self-Contained Electric Locomotive.—The Electrical Power Storage Company have received from Messrs. Edwin Andrén and Co., of Göteborg, a letter testifying to excellent working of an electric locomotive supplied to the Skutskär sawmills in January, 1892. Since that time the accumulators with which the locomotive is equipped have been charged 631 times—in all about 2,000 hours—and up to the present not a single plate has either been destroyed or been required to be replaced. The plates continue to be in full working order.

Gas versus Electric Light.—The end of the dispute between the Limoges Municipality and the gas company, on the ground of the former having licensed an electric company to the detriment of the latter, is that in the meantime the electric lights have had to go out. The *Gas World* states that this is the fourth case—Saint-Etienne, Montluçon, Argentan, and Limoges—in which the French Courts have compelled municipalities to keep to the terms of their agreements with gas companies in this respect.

Leeds Tramways.—The Leeds Corporation Tramways Bill, against which petitions have been deposited by the Lancashire and Yorkshire and Midland Railway Companies and the Yorkshire House-to-House Electricity Company, came on Tuesday before the House of Commons Committee on Standing Orders. After a brief deliberation in private, the agents for the Bill were informed that compliance with standing orders would be excused on the same conditions as were imposed in the House of Lords—namely, that the powers relating to the construction of generating stations should be struck out of the Bill.

Magnetism and Compasses.—In the past it has been the practice, the *Times* states, to "swing" vessels of the Royal Navy for the purpose of ascertaining the effects of the dynamos on the compasses, but in future this is to be discontinued on second-class cruisers, which are fitted with automatic switches for obviating the effects of the dynamos in disturbing the compasses fitted on the aft bridge and other compasses fitted in the aft part of the ship. The accurate working of the switches is tried by observing the deviation with the ship's head on the north or the south point, first, with both dynamos running; secondly, with the starboard dynamo running; and, thirdly, with the port dynamo running.

Iron and Steel Institute.—A batch of pamphlets, being reprints from the *Journal* of the Iron and Steel Institute, has been forwarded to us by the secretary. The pamphlets include, amongst others, "Notes on Electric Power," by Mr. D. Selby-Bigge; "Early History of Crucible Steel," by Mr. R. A. Hadfield; "Colour Gauges for Carbon Testing," by Mr. W. G. McMillan; "Influence of Aluminium upon the Carbon in Ferro-Carbon Alloys," by Mr. T. W. Hogg; "The Manufacture of Coke," by the late R. de Soldenhoff; "The Manufacture of Steel in the Open Hearth," by Mr. J. A. Lencauchez; and "Iron and Steel Industries of Belgium," by Prof. A. Gillon. The discussion on the papers is also given.

Telephony in Germany.—The Imperial Diet on Monday discussed the estimates for the posts and telegraphs. The first demands submitted to Dr. von Stephan included a reduction in the charges for the use of telephones. The Secretary of State remarked in regard to this suggestion that Germany was far ahead of other countries in telephony. In the whole of France there were not so many telephones as there were in Berlin alone. In the empire at large there were 378 places with telephonic communication, with a total of 84,920 instruments. But the financial objections against the reduction of the charges for the telephones and against an increase in the weight of single letters did not permit him to take the desired reforms in hand.

Indiarubber-Covered Cables and Wires.—A revised price-list of pure and vulcanised rubber-covered cables has been issued by Messrs. Johnson and Phillips, who occupy a prominent position in this branch of industry. The list contains a table of the gauge, sectional area, and carrying capacity of copper conductors, and gives details

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of the various classes of cables and wires made by the firm. Apart from the fact that the firm's cables are used by many of the most important electrical wiring contractors, Messrs. Johnson and Phillips are also supplying quantities of high-pressure rubber-covered cables to different supply stations for underground work. As an instance of the test to which these cables are put, it may be mentioned that they are tried with an alternating current of from 4,000 to 10,000 volts from core to earth.

Electric Tramway at Nice.—Some time ago, M. A. Sénéchal, manager of the Nice Zoological Gardens, obtained a concession for the construction and working of an electric tramway between Nice and Cimiéz. This line, which is about to be set in operation, has been laid down by Mr. G. Averly, of Lyons, the gauge being 60 centimetres. The tramway is to be worked by storage battery cars of the open side and end type, and having a passenger capacity of 32 persons. The generating station contains plant for the charging of the batteries. The cells are of the Laurent-Cely type, and each car is equipped with 90 cells, capable of furnishing sufficient energy for driving the motors and car for one hour, or, say, three journeys. The weight of each car battery is 2½ tons, and the car is equipped with two electric motors, driving the axles by means of toothed gearing. Experimental runs have already been made with some of the cars.

Prevention of Pipe Corrosion.—A communication dealing with rail-bonding and its bearing on electrolytic corrosion, by Mr. George P. Low, is given in the February issue of the *Transactions* of the American Institute of Electrical Engineers. It forms a sequel to the discussion of a paper by Mr. J. H. Farnham on the "Destructive Effects of Electric Currents on Subterranean Pipes," read before the institute in April of last year. Mr. Low concludes that the art of rail-bonding now appears to have been perfected, and the damage that has been caused by corrosive electrolysis may be attributed to defective bonding, for without doubt proper main-to-track, rail-to-rail, and track-to-dynamo bonding will cure the ill almost without exception. Should the street railway companies delay in correcting the evil it is probable that municipal authorities will take action for the protection of citizens in their vested interests, in which event the conditions now existing may be further and seriously complicated by ill-advised municipal exactions. The problem of eliminating electrolytic corrosion is, in brief, simply one of judicious bonding.

Metric System of Weights and Measures.—Mr. Alex. Siemens was the first witness called on Tuesday on the resumption of the hearing by the Select Committee of the House of Commons of evidence in connection with weights and measures. He declared himself in favour of the metric system, and stated that he had adopted it at his own works for the smaller measurements. Engineers generally were obliged to use the metric system for engines which were ordered from abroad. He thought that there would be a very considerable saving of work if the metric and decimal systems were adopted in this country. The system of testing weights and measures in Germany was practically the same as that obtaining in England. If the metric system were adopted by this country, he believed that the present staff of inspectors could easily standardise metric weights and measures. When the change to the metric system was made in Germany it was found possible to convert a large proportion of the weights and measures then in existence; and he did not think that it would be at all difficult to make English weights available under the metric standard. The retail traders of Germany made no great objection to the metric system; on the contrary, they rather welcomed it. They soon recognised its advantages over the old system, and its smaller liability to admit errors. The same might be said with respect to the decimal coinage.

Electro-Harmonic Society.—A smoking concert will be held on Friday, the 29th inst., at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., commencing at eight o'clock. The following is the programme: Part I.—Quartette, "Robin Adair," the "Vernon Lee" Part Singers; song, Mr. Wingrove Ives; pianoforte solo, "Tarantella" (Moskowski), Mr. Alfred Izard; song, "The Sailor's Grave" (Sullivan), Mr. Harry Stubbs; humorous recitation, "Astronomy Made Easy" (Anon), Mr. W. G. Churcher; violoncello solos, "Herbstblume" and "Papillon" (Popper), Mr. Allen Gill; song, "Star of the Desert" (Bonheur), Mr. Harry Marriott; humorous sketch, "Ganthony's Grotesques," Mr. Robert Ganthony. Part II.—Quartette, "The Ash Grove," the "Vernon Lee" Part Singers; song, "The Wonders of the Deep" (W. H. Jude), Mr. Wingrove Ives; instrumental trio, "Molto Allegro" from Op. 49 (Mendelssohn), Messrs. T. Gatehouse, Allen Gill, and Alfred Izard; humorous recitation, "The Cricket Club of Red Rose Flat" (Wood), Mr. W. G. Churcher; violin solo, Mr. T. E. Gatehouse; song, "A Spring Song" (Leoni), Mr. Harry Stubbs; humorous sketch, "Black and White Art," Mr. Robert Ganthony.

Electrical and Allied Trades Section.—A meeting of this section of the London Chamber of Commerce will be held at Botolph House, Eastcheap, E.C., on Monday, the 18th inst., at 12 noon, to deal with the following business: (1) To consider the proposed telephone agreement between H.M. Post Office and the National Telephone Company, and what steps should be taken to obtain an expression of the views and adequate representation of the interests of the commercial community before the parliamentary enquiry to be held on the subject; (2) to consider the report of the Board of Trade Departmental Committee on Light Railways, and whether any action should be taken in connection with the Bill about to be introduced by the Government; (3) to consider what action, if any, should be taken in connection with the appointment of a select committee of the House of Commons to enquire "whether any and what changes in the present system of weights and measures should be adopted"; (4) to consider the Government Factory and Workshops Bill, and whether any action should be taken in connection therewith; (5) to consider whether the section should offer a prize or prizes for proficiency in electrical subjects, under the commercial education scheme of the Chamber; (6) to appoint representatives of the section on the following standing committees of the Chamber: Bills of Lading Committee, Commercial Education Committee, Commercial Law Committee, Exhibitions Committee, and Postal Committee.

Employes in the Post Office Service.—The secretary of the London Trades Council recently forwarded to the Postmaster-General a copy of a resolution passed at a delegate meeting of the council, calling on him "to observe the same conditions and customs in the electric lighting department at Mount-pleasant as are observed in the various shops in the London district, and abolish the present system of piecework in existence at the instrument factory at Holloway, where it is possible for a recognised skilled mechanic to earn the sums of 7s., 9s., and 11s. for three consecutive weeks' work." The following reply has now been received from Mr. S. Walpole: "I am directed by the Postmaster-General to acknowledge the receipt of your letter of the 21st ult., enclosing copy of a resolution adopted at the general delegate meeting of the London Trades Council on the 14th ult. Mr. Arnold Morley cannot admit that the charges made by the deputation which he received on June 29 last, consisting of repre-

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sentatives of the Electrical Trades Union, Scientific Instrument Makers' Trade Society, and members of the executive, have been proved by the answer which he caused to be addressed to you on November 9. On the contrary, he believes that that answer disposed of the points brought forward by the deputation. As regards that part of the resolution which recommends the abolition of piecework, I am to inform you that since the date on which the resolution was carried, the men employed at piecework rates at the instrument factory have unanimously adopted a memorial asking that no change may be made in this respect."

The Government and Telephony.—In the House of Commons on Wednesday Mr. T. Ellis moved that the Select Committee on Telephony should consist of 15 members; that Captain Bagot, Mr. Baird, Mr. Benn, Sir C. Cameron, Mr. John Ellis, Sir J. Fergusson, Sir J. Goldsmid, Sir J. Gorst, Mr. Grant Lawson, the Solicitor-General, Mr. Arnold Morley, Mr. Moulton, Mr. Snape, Lord Stanley, and Mr. Tulley be members of the committee; and that the committee should have power to send for persons, papers, and records; five being a quorum. Mr. A. C. Morton appealed to the Postmaster-General to reconsider the list of names with the view of giving a larger representation to the City. Mr. A. Morley said that London already had three members, which was more than its share as compared with the representation of the rest of the country. Mr. A. C. Morton said that two of the three members represented the County Council, and it could not be said that one was a fair representation of the City. He persisted in his objection, and the matter therefore stood over.—The Highways Committee of the Leeds City Council had under consideration on Wednesday a communication from the parliamentary agent of the London County Council, suggesting that a few of the leading corporations should appear before the Select Committee of the House of Commons appointed to consider the subject of telephones in relation to municipalities, and the sufficiency of telephonic arrangements. The committee resolved to agree to the suggestion, and a committee, composed of the Mayor, Alderman Ward, and Alderman Firth, was appointed in regard to the matter.

Water Power in Scotland.—In connection with the scheme referred to in our issues of the 22nd ult. and 1st inst. for the utilisation of the Falls of Foyers, near Loch Ness, Mr. A. C. Morton asked the Secretary for Scotland, in the House of Commons last week, whether his attention had been drawn to the subject, and, if so, whether he would take measures to prevent the destruction of what was of national interest, especially to tourists. Dr. MacGregor wished to ask the right hon. gentleman, as these falls were part of his constituency, whether there were not two sides to the question? Whilst he should deprecate the destruction of such grand and beautiful falls just as much as anybody else would, he could not help asking the right hon. gentleman to consider whether, especially as public works and factories were so scarce in that part of Scotland, it was not more desirable to encourage work of this kind than to discourage it, so that some employment might be found for the people in the locality. In reply, Sir G. Trevelyan said that his hon. friend had given him a serious problem to solve, but it was one which lay rather with the County Council than with him. He was informed, however, that the County Council had not yet met to consider the question referred to, but a meeting of the County Road Board, preparatory to holding a meeting of the Council, was called for Friday next to consider whether the Aluminium Company could be allowed to submerge roads near Foyers in carrying out their proposed works. The company denied that the falls would be destroyed, but the volume of water would no doubt be lessened at certain seasons of the year. The question, however, was receiving the attention of the County Council, who were, it appeared to him, the proper authorities to deal with the matter.

Potential Differences between Metals and Electrolytes.—In the *Journal* of the Chemical Society there appears an abstract of a paper by Mr. V. Rothmund in the *Zeit. Physikal. Chem.* on this subject, in which it is stated that a capillary tube containing mercury or a liquid amalgam dips into a small cup containing mercury, covered by the electrolyte, and the capillary and electrolyte can be brought to any required difference of potential by means of a set of resistance coils and a Leclanché cell. The capillary tube is connected with a manometer, and the mercury always brought to the same point by an increase or decrease of the manometric pressure. When the E.M.F. due to the cell is equal to that between the amalgam and electrolyte no charge is received, and the surface tension is a maximum; the method hence consists in varying the difference of potential due to the cell until the manometric pressure required to bring the amalgam to its constant point reaches a maximum. Measurements were made with mercury and amalgams of lead, bismuth, tin, copper, zinc and thallium, the electrolytes being sulphuric acid saturated with a salt of the dissolved metal and with a complex mercury salt such as mercuric potassic iodide. The E.M.F. of various galvanic chains were calculated from the results and compared with those obtained by direct measurement. The agreement was in most cases very satisfactory, so that the potential difference between the two metals or two electrolytes has but a slight influence on the E.M.F. of the cell. Variations occurring in the cases of the amalgams of tin, cadmium, and thallium are probably due to the action of the acid on the surface of the amalgam. Discordant results were also obtained in the experiments with the complex salts, where it is noticeable that the absolute value of the surface tension at the maximum was below the normal value, in which case the author does not consider the method to be applicable.

The Government and Telegraphy.—The Postmaster-General, speaking on Wednesday at a meeting of the Association of Chambers of Commerce, said that the time might come when the Department with which he was connected might have more direct control over telegraphic communication, but at present, with the exception of certain cables across the Channel to the Continent of Europe, they had no control over the foreign Imperial telegraphic cables of the world. They were in the hands of companies. He should certainly put no difficulty in the way, but should be prepared to give the advantage of the experience he had gained at the Post Office in helping on any reasonable extension of the system of Imperial communication between the different parts of this great Empire. In regard to the substitution of underground cables for overhead wires, he had had an estimate prepared for a system which would allow underground communication between London and 66 of the principal provincial towns and 88 junction lines between the principal provincial towns, and he found that the cost would be something like 2½ millions sterling. That was an amount which, in view of the serious and heavy loss on the Telegraph Department of the Post Office, he should certainly view, and he was certain the Treasury would view, with grave misgiving. They had met the difficulty of interruption from storms and other obstructions by creating alternative systems of communication between telegraphic centres.

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To the West of England there were two routes, and to the North three, and he was confident as time went on these difficulties would be minimised. The Post Office had developed the telegraphic system of this country during the past 25 years in a way unequalled in any other country of the world. The Government had now taken over the trunk telephone wires of the country, and he believed that in the development of the telephonic system equal activity would be shown.

Ventilation of Street Boxes.—The London County Council is insisting upon proper means of ventilating the street boxes being adopted by existing companies in cases of any extensions of their mains. The House-to-House Company desire to lay mains in Cheniston-gardens, Cromwell-road, and in Brechin-place. Sanction has been given to this proposal on condition that the mains are laid under the footways wherever it is found practicable to do so; that the low-pressure mains be placed 9in. below the underside of the paving, and those of high-pressure at least a foot lower; that no pipes of a larger diameter than 3in. be used; that no street boxes be constructed until full details showing adequate provision for ventilating them shall have been submitted to and approved by the Council's chief engineer; and that separate boxes be used for the high and low pressure mains respectively. The London Electric Supply Corporation, who want to lay distributing mains in Pavilion-road, Daycott-place and street, Cadogan-gardens, Dilke-street, Cheyne-walk, and the Chelsea-embankment, can do so by putting the mains under the footways 9in. below the underside of the paving wherever practicable, but they must not construct street boxes until the positions for and the mode of construction showing adequate provision for ventilating the boxes, have been approved by the Council's chief engineer. Moreover, the Council say that all cables crossing the boxes must be supported from below in the boxes; all service lines or small cables must be protected where leaving the boxes by an extra lead covering or by wooden stoppers, and also have a copper wire of sufficient size carried from the service to the main cable in good connection with the lead or iron outer casing; and the ends of all mains terminating elsewhere than in a box are to be securely protected by iron caps, in addition to any other covering. The Westminster Company, who intend to lay mains and construct street boxes in Gardiner's-lane, Caxton-street, and James-street, are ordered by the County Council to submit to its engineer details of the street boxes to be used, showing adequate provision for ventilating them, and the covers of the boxes are to consist of iron frames filled in with materials to suit the paving.

Electrical Energy from Cold Combustion of Gas.—A note on this subject appears in the New York *Electrical World* from the pen of Mr. Carl Hering. The writer says: "In connection with the recent experiments of Dr. Borchers, which have been attracting so much attention, the following simple little experiment made in 1883 by Mr. von Dobrowolsky and myself, at the suggestion of the former, may be of interest, as it seems to show conclusively that a cell can readily be made in which the cold combustion of coal gas (or at least some constituent part of it) with atmospheric air will take place, yielding its energy in the form of an electric current. Two carbons, such as used in Leclanché cells, were carefully cleaned and platinised with platinum black; they were then placed in dilute sulphuric acid and kept short-circuited for some time in order to discharge them, should there be anything different in the two causing a difference of potential. One was then placed in a jar containing ordinary illuminating gas from the street mains and the other was held in the air. After a while they were inserted in the dilute sulphuric acid and connected to a crude galvanometer made of a small coil of wire around a pocket compass. The current obtained when started and stopped at proper time intervals caused the needle to spin around on its pivot with considerable speed. It may, therefore, be said that a motor, although only an infinitely small one, was run with the energy thus obtained. No further measurements were made, as it was considered to be of no practical interest and as we had no suitable measuring instruments at the time. I believe that the problem of the conversion of the energy of coal into electrical energy without the aid of that frightfully wasteful converter, the steam engine and boiler, will be solved first by some of the numerous possible indirect ways. If scientists and inventors would direct their attention to these rather than to the direct methods, we would, I think, be relieved much sooner from the necessity of using the wasteful steam engine and boiler, which, although very useful in the absence of something better, must still be regarded as merely a temporary, unsatisfactory makeshift. The efficiency of the engine-boiler converter is so very low that it will require but a very poor and inefficient electrical converter to relegate it to the museums."

Lighting of Joiners' Shops.—An interesting installation has just been completed for the lighting of the new joiners' shops recently built by Messrs. J. L. Thompson and Sons, North Sands, Sunderland,. The plant consists of a "Tyne" compound-wound dynamo, capable of giving 400 amperes at 65 volts when running at approximately 600 revolutions per minute. The machine is fitted with an extended bedplate with outer bearing and a very heavy flywheel, so that an absolutely steady light will be obtained when driven by a gas-engine, but at present the dynamo is operated by the existing steam-engine which drives the bending rolls and other machinery in the ship-repairing yard. The current from the dynamo is taken to a main switchboard, and is from there divided into three circuits. One circuit is taken overhead to the joiners' shop, the second is carried along the jetty for energising cluster lights for repairing oil ships, etc., and also for working electric deck planers and drilling machines, and the third circuit is provided as spare, as the firm contemplate applying electricity for other purposes. A distributing switchboard is placed in the joiners' shop on the first floor, and from this board 18 arc lamps of 2,000 c.p. each are fed, the lamps being on separate circuits so that any lamp can be switched on or off as required. The arc lamps are exceedingly simple, and are fitted with light flashed opal globes with solid bottoms, so that it is impossible for any sparks or pieces of carbon to fall down. This is an extremely important matter in a joiners' shop where shavings are lying about, and these lamps particularly meet the requirements of the case. Five arc lamps are placed on the ground floor and 13 on the first floor, the ground floor being reserved for heavy plant and the first floor for light machinery. The varnishing-shop and light joiners' shop are lighted with 16-c.p. incandescent lamps, there being between 40 and 50 lamps of this type. Along each side of the first floor and ground floor a separate circuit is laid with wall plugs about every 10ft., portable hand lamps being provided so that the shafting or underside of any of the wood-working machines can be quickly examined. This installation is of a very complete description, and owing to the abundance of light provided there is no doubt that Messrs. Thompson will find a very great advantage in the rapid production of their work by adopting the electric light. Messrs. Ernest Scott and Mountain, Limited, of Newcastle-upon-Tyne, have carried out this installation.

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NEW ALTERNATING-CURRENT ARC LAMP.*

Amongst the numerous applications of polyphase currents, their use in regulating arc lamps, by the Nuremberg Electricity Company, formerly Schuckert and Co., is interesting and important. All arc lamps for alternating currents which have hitherto been used or proposed have almost invariably had a rack arrangement and gearing, which are released as soon as the consumption of carbon has so far advanced that the pressure at the electromagnets has reached a certain limit. This intermittent regulation is the cause of certain inconveniences, as, for example, irregularity in the light at different times. The regulation of this new arc lamp is, however, continuous, the carbons being steadily pushed forward.

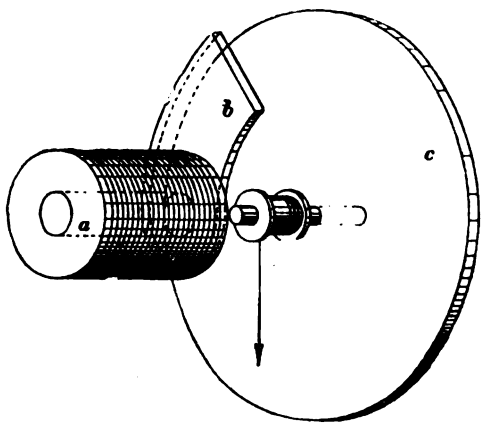
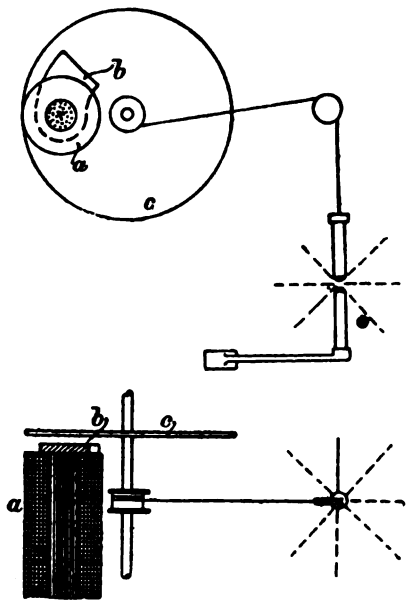


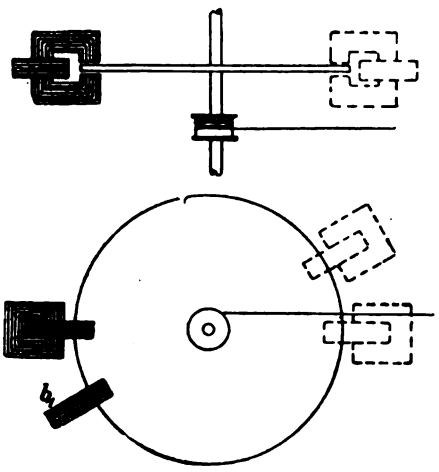
FIG. 1.

The arrangement is shown in Figs. 1, 2, and 3. A copper disc, *c*, revolves in front of an electromagnet, *a*, whose core is made of laminated iron, and whose poles terminate in strips like *b*, or some other suitable shape. When an alternating current is passed through the coil the copper disc is caused to revolve, because by each change of poles first the core of the electromagnet and then the



FIGS. 2 AND 3.

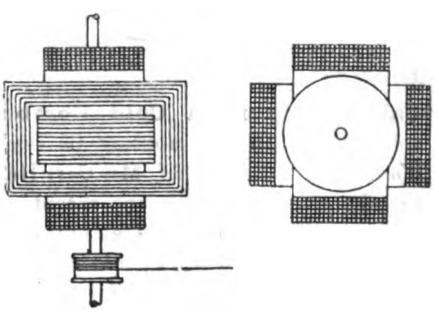
strips, *b*, are magnetised; the parts furthest away from the electromagnet last—*i.e.*, there is a magnetic wave from the core of the electromagnet to the extremities of the strips. By the causing of eddy currents in the copper disc a tendency to rotate is developed, varying according to the force of the current and number of times the poles are reversed, and having a tendency to take the disc round with it. If the disc is connected with the carbon-holder by a suitable mechanism, in such a manner that a constant weight balances the tractive force (in the drawing this is done by means of a cord), we then have an arrangement equally suitable with a single coil for lamps on a main or a shunt circuit, or with two coils as a differential lamp. Modifications of this arrangement have been introduced. In Figs. 4 and 5 a coil is shown on the left, whilst the influence on an adjoining core, b_1, causes the displacement of the field. On the right is another variation of the arrangement; two electromagnets are shown in dotted lines. Instead of this, four can also be used, spaced symmetrically 90deg. apart, or two close together, as shown in Fig. 5. A periodical displacement of the field can also be caused by having both electromagnets in the main current, or both in the shunt-current circuit, but by different winding, or with



FIGS. 4 AND 5.

differently-shaped iron cores, they have different coefficients of self-induction, and therefore a difference of phase arises. Figs. 6 and 7 show an arrangement by which the magnetic field turns in a well-known manner (Ferraris), and a rotary impulse is exercised on the metallic body. The copper disc is replaced by a cylinder, which can be made of copper or another conducting material. In the drawing, however, the body which rotates is made of thin discs of iron insulated with paper, so that the effect of the eddy currents is compensated by the retarded magnetism.

Fig. 8 and 9 show an elevation and a plan of the type of arc lamp carried out. On the plate, *h*, are four small columns, *i*, which carry the whole mechanism. By means of two cross-pieces, *d*, they carry the electromagnets, *a*, with their iron cores, *b*, as well as the iron pieces, b_1 b_1, and, lastly, the metallic disc, *c*. The cores, *b*, of the magnets, *a*, are most suitably made of thin sheet iron; whilst the



FIGS. 6 AND 7.

pieces, b_1 b_1, had better be of solid material. The metallic disc, *c*, revolves between the cores, *b b*, and through openings in the iron pieces, b_1 b_1. A pulley, *f*, is in communication with this and carries the cord, *g*, which leads to the carbon holders.

The manner in which the mechanism of the lamp works is as follows: Through the weight of the carbon-holder and carbons the latter have sunk until the points touch. The alternating current which supplies the lamp flows through the electromagnets, *a*, and periodically, as the poles change, magnetises the iron cores, *b b*. The pieces,

* Abstracted from the *Elektrotechnische Zeitschrift*.

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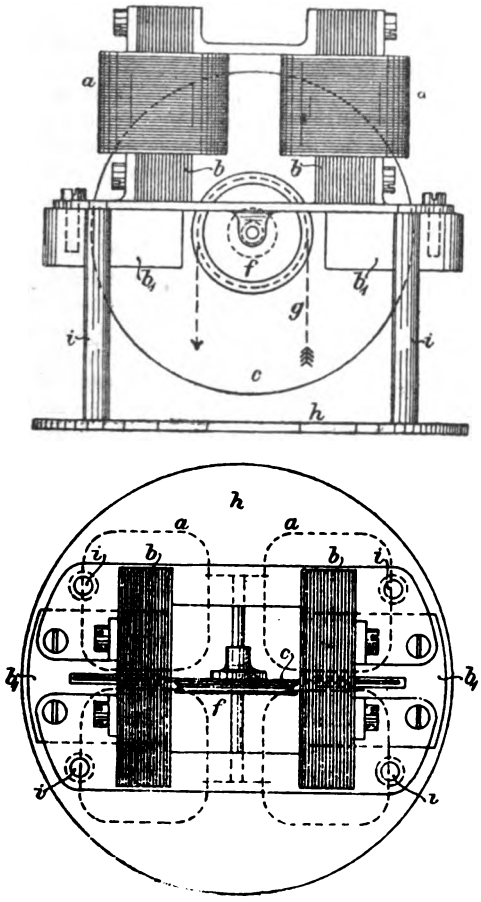
b_1 b_1, next become magnetised, but not till after the cores, or, in other words, a magnetic wave passes from the laminated core to the solid pieces of iron. The wave takes its rise in the core, passes into the pieces of iron, and there dies away. This magnetic wave causes eddy currents in the copper disc, which create an attractive force, and therefore a tendency to rotate in the opposite direction to the wave. The copper disc is thus caused to revolve, and by means of the pulley and cord this brings the carbons apart. Hence a weakening of the power of the electromagnets takes place until the strain on the copper disc is balanced by the weight of the carbon-holder.



FIGS. 8 AND 9.

To obtain a practical and useful construction, it is necessary that there should be a considerable difference in phase in the periodically changing magnetism of the two pieces of iron, as it is only thus that a compact form becomes possible. With this object the pieces of iron which are to be secondarily excited are separated by a layer of low permeability, so that the laminated electromagnets induce electricity in the disc, and the Foucault currents in the disc work on the secondary masses of iron.

THE SCIENTIFIC FOUNDATIONS OF ELECTRICAL ENGINEERING.*

BY F. G. BAILY, M.A., MEMBER.

There is probably no branch of engineering which is more intimately connected with purely scientific knowledge, and which has received more attention from scientific men, than electrical engineering. The novel character of the forces which it employs, their intangibility and mysterious nature, appeal strongly to the imaginations of the uninitiated, and seem to set apart everything connected with electricity as a class of phenomena about which very little is known or understood. On the other hand, a certain amount of familiarity with the more usual phenomena and the acquisition of several formulæ has produced in some minds a profound conviction of the truth of electrical theories, with an implicit faith in the accuracy of electrical measurements and the potency of calculation. While leaving the former attitude of mind to the gradual effect of familiarity, I wish to mention in this paper some of the limits to which we are still subject and some of the errors to which we are specially liable.

The most powerful aid to improvement, and the greatest source of confidence in engineering practice, is undoubtedly by accuracy of measurement of effects and quantities in units which are common to all branches of physical knowledge. It is, therefore, useful sometimes to examine our foundations and realise what they mean. In accordance with its close connection with pure science, the units employed in electrical engineering have been based on the so-called "absolute" system of units—that in which the centimetre, gramme, and second form the fundamental quantities, the definitions of which depend on the physical properties of certain portions of the universe. Physical science refers all its measurements to these three fundamental units, and recognises no others. As these units are independent, all calculations based on them may be accepted as rigidly accurate, and strictly comparable with one another. Abstract calculations are not, however, of much direct use to the engineer, and something more definite is required. Now, the E.M.F. of a battery, the current in a lamp, or the resistance of a piece of wire does not appear to be very closely related to grammes, centimetres, and seconds, and, in fact, they can only be numerically estimated by indirect experiment. After a long series of extremely careful work, the values of electrical and magnetic quantities have been determined to a certain degree of approximation, so that the values of any particular resistance can be expressed in centimetres and seconds to an accuracy of ·01 per cent., or even less.

The electrical and magnetic units are derived from the centimetre-gramme-second through the mechanical forces which the various quantities exert, starting from the force between two magnetic poles, and the force on a magnetic pole in a magnetic field. Hence current is measured by the strength of the field it produces, and E.M.F. by the motion of a conductor in a magnetic field. Resistance is defined as the ratio of these two. This system, however convenient for scientific purposes, does not lend itself readily to the reproduction of the units. In practical work it is important that the standard values should be readily reproduced and easily compared to others. On this account the Board of Trade have laid down that the practical standards, while being made as closely equal to the true absolute values as possible, shall be independent of them and independent of possible future more accurate determinations of the true values. The ohm is defined as the resistance of a certain quantity of mercury of certain length, and the ampere as a current which will deposit silver out of a certain solution at a certain rate. The volt is, then, the E.M.F. necessary to drive one ampere through one ohm.

In accepting these definitions we really leave the centimetre-gramme-second system and found another one very closely related, but arranged on a different and more convenient principle. To what extent is this accurate, and to what accuracy can we compare electrical quantities on this system?

It must be confessed that the measurement of electrical quantities has not the same accuracy as the measurement of the fundamental mechanical quantities, and the laws upon which they depend are not to be depended on to the same extent. The laws of motion laid down by Newton have an accuracy which may almost be regarded as absolute. We have no reason for doubting them. The standards of length and mass may conceivably alter in the course of ages, but there is no evidence of such a change having taken place. But the electrical units are not so firmly established. The electrical resistance of standard ohm coils has been found to vary to a small extent, but this unit is the most satisfactory one, and comparisons between it and others can be made with considerable accuracy, one part in 10,000 being easily obtainable. The standard current depends on Faraday's law of electrolytic action, and though this may be theoretically very approximately

* Paper read before the Northern Society of Electrical Engineers, March 11, 1895.

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true, its actual truth is marred by secondary actions, which prevent an accuracy greater than one part in 1,000. The volt depends on this, and therefore no measurement of current or of E.M.F. can be relied on beyond one part in 1,000.

This question of the limit of accuracy of measurement of the actual and relative values of quantities is one which is frequently ignored. There is no such thing as the knowledge of the absolute value of any quantity. We can only know its value to a certain approximation, and this should be definitely expressed by the figures used, and it is useless to try to push this limit beyond the limit of the standards. Sometimes this standard is very imperfectly known—*e.g.*, the value of the unit of heat is not reliable beyond one part in 400 at the most.

Frequently, however, the number of figures intended to denote a value are not justified by the degree of accuracy of the experiments by which it has been determined. The accuracy of a result is the accuracy of the weakest part, like the strength of a chain. The determination of other values involved to a much greater degree of accuracy is mere waste of time, while the quoting of them is deceptive. How often does one see a reading on a galvanometer consisting of two figures expanded by a long division, or by the use of seven-figure logarithm tables, into a result of some five figures. The last three figures are purely gratuitous, and are quite unreliable.

The same fictitious accuracy is often seen in the design of measuring instruments. It is not infrequently the custom to design voltmeters with an expanded scale over a short range, and to advertise accuracy of scale reading to $\frac{1}{10}$ volt at 100 volts—that is, an accuracy of one part in 1,000. This is merely the seven-figure logarithm over again, it being useless to magnify the scale beyond the size where the errors due to friction and the effects of temperature and residual magnetism become appreciable distances on the scale.

Under this head I feel compelled to mention an instrument for which I have a great admiration, and which has recently been eulogised before another society. I refer to the potentiometer. The delicacy is very great, almost comparable with that of the Carey-Foster method of comparing resistances, the Whitworth measurement of length, and the measurement of mass by the chemical balance, and for comparative values taken at short intervals of time it is unrivalled in its own line. But for actual values it is like using a delicate balance with a set of letter weights, or a Whitworth machine with a common foot rule, as standard. A delicate method of comparison is useless beyond the point of reliability of the standard, which in this case is one part in 1,000. Even this is by no means easy to attain. Such an accuracy on the silver voltameter requires great practice and very careful work, while the Clark cell requires just as careful handling. It is not an immutable thing—like a gramme weight of platinum, crystal, or gilt brass—but it is generally used with as little regard for its peculiarities. Notwithstanding its large temperature variation, the worker ignores its previous condition, and with a light heart applies a thermometer and a table of corrections, as if the E.M.F. had some direct connection with the mercury in the thermometer, instead of being related only by the very indirect and slow-acting conditions of solution or deposition of sulphate of zinc.

The essence of applied science is emphatically the power of measurement for the purpose of checking the accuracy of previously calculated or estimated designs, and for investigating the properties of materials used, in order to obtain data for future work. We may divide experimental research into three classes: (1) qualitative observation of the occurrence or non-occurrence of some phenomenon; (2) comparative quantitative observation of the variations of a phenomenon, with change of conditions; (3) absolute quantitative determination of the value of a phenomenon. The first two classes include the bulk of scientific research, for the absolute value is frequently of minor importance and depends on the particular piece of matter used, while the changes in value are common to a large class of bodies, and indicate physical laws. The determination of the absolute value of an important physical quantity to a high degree of accuracy is a matter of great difficulty, and forms the object of some of the most laborious investigations. To a large extent, however, the engineer can only deal in absolute values, because he immediately wishes to compare the result with that given by some other arrangement of his machinery. With him the all-important question is by what method a certain result can be most economically obtained, using the word "economy" in its widest meaning. For instance, a physicist or chemist may be interested in the various processes in the production of mechanical energy by the consumption of coal. The effect of varying the supply of air to the fuel, the wetness of the steam, the result of altering the initial pressure, the expansion and condenser pressure, the surface condensation under different conditions, and many other points, are all problems of scientific interest, and may be dealt with separately. But the engineer must take all of these points into consideration at once, make the best compromise that he can between conflicting requirements, and sternly require of each improvement that the resulting increase in efficiency shall not be swallowed up by the increase in cost of plant and labour. Finally, he must compare the total result with that given by some other means of obtaining mechanical energy, in order to make a final decision.

For this reason, therefore, the method of investigating engineering problems must, to a certain extent, differ from the purely scientific treatment. The scientist narrows the conditions of his problem and simplifies the phenomena until the result, though highly artificial, illustrates the action of a single law. For the engineer, on the other hand, it often seems difficult to avoid the combination of all the variables, and in consequence he hardly differentiates their individual effects, and does not always discern which of them are essential and where the point of weakness lies. That truly English panacea, a substantial factor of safety, is made to take the place of more precise knowledge, the additions being occasionally put in quite unnecessary places.

On the other hand, much time and energy is expended, especially by mathematicians, in elaborating hypothetical problems, the conditions being chosen to suit their method of analysis, and the desirability, and even the possibility of realising those conditions, being disregarded. This has been especially the case with alternating-current problems. It seems a field so evidently made for mathematical treatment of an interesting nature, and so impossible to attack by any less rigid method of reasoning, that one almost feels called upon to give up the use of such an unreasonable material as soft iron, and even to abjure the use of most dielectrics, in order to rest in the security of an analytical demonstration.

It is necessary, therefore, to beware of the spurious accuracy of the page full of mathematics just as much as the seven-figure logarithms. It has been pointed out, but the caution is frequently ignored, that mathematics is like a flour mill. The quality of the flour turned out is not better than that of the corn put in, and if not ground with due care and precaution, may be a good deal worse. If the data are unreliable, or if the proportion dealt with cannot be expressed as a mathematical function, the results can have but a very limited application. Examples of this are often met with in calculations of cost and efficiency, where wonderful coefficients and constants stand for interest, depreciation, labour, superintendence, load-factors, commercial efficiencies, plant efficiencies, and other quantities and values, which are familiar enough to the engineer, but of which the laws are only imperfectly known.

It must not be thought, however, that I wish to disparage scientific principles and methods in electrical or in any other branch of engineering. There is no other safe foundation, especially in electrical work. The agents and phenomena are so intangible and unusual that the old-time faculty of experienced intuition, by the light of which an engineer was supposed largely to work, is exceedingly difficult to cultivate, and frequently leads the possessor startlingly astray. What we want is more appreciation of actual working conditions in our mathematics, and a more scientific direction and greater breadth of applicability in our engineering experiments. This latter need is the weakest part of all engineering science, and the most important. An isolated case of a machine which works

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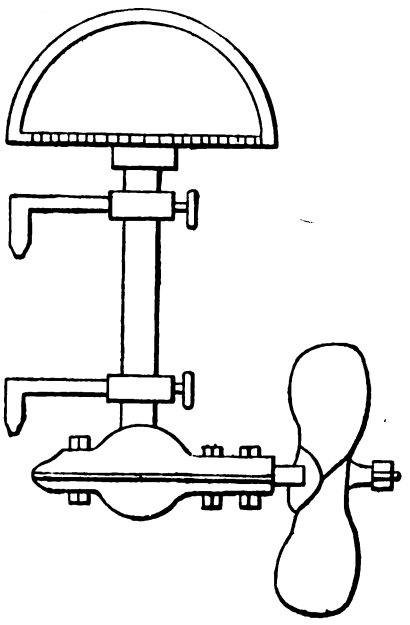
well contributes little to knowledge. A similar case of one which works badly gives not much more information. But it is perhaps unreasonable to expect manufacturers to build a series of experimental machines, each differing slightly in one particular, to settle the absolutely best conditions, or if this is done, as has been sometimes the case, the world at large can hardly expect to have the benefit of the work presented to it. Moreover, workshops are not the best places for research, nor is engineering experimental work a pastime at which untrained players can get results of any value. It is so easy to obtain some sort of result in experimental work; it is so difficult to attribute it to its true cause and to eliminate all side issues. From the nature of the case, secondary actions crowd round the main point, and but few men have both time and ability for elucidating them. Much good work has been done in the factory, but, as stated above, it is generally of an unobtrusive nature. Much has also been done in physical and technical laboratories, and I venture to think that manufacturers, central-station and consulting engineers will find that a greater amount of sympathy with these institutions, and mutual assistance and collaboration with them, will result in true economy to themselves, and will greatly help to establish a firm scientific foundation for electrical engineering.

MCLACHLAN'S ELECTRIC RUDDER.

Some time ago we referred to this appliance, the object of which is to provide a propelling apparatus which may be attached to, or detached from, an ordinary skiff boat or canoe in a few minutes without the necessity of altering the vessel to which it is attached. The electric rudder,



which is illustrated herewith, weighs complete about 45lb., and the accumulators about 85lb. Sufficient energy is stored, we are informed, to propel the boat for eight hours at a speed of five to six miles an hour. The complete apparatus can be supplied at about one-third the price of an ordinary electric launch. Mr. E. A. McLachlan, of 55, Brighton-road, Stoke Newington, N., will be glad to furnish any further particulars.

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 14.

THE ELECTROLYSIS OF GOLD.

BY N. S. KEITH, MEMBER.

Obtaining the contents of gold from auriferous rocks and ores by means of solvents and subsequent precipitation is now attracting much attention, in both scientific and financial circles. Because in some of the practised plans electricity takes an important part in the operations, I think some electrical information relating to the matter will be acceptable; therefore this paper,

In fully considering the subject, we would have to enter into the question of the possible formation of native gold in rocks and ores by electro-deposition from the solvent waters of the earth by action of earth currents. But, as my paper is to deal more with practice than hypothesis, I shall leave that matter to the side, after stating a fact from which various deductions may be drawn. At the Dorn Gold Mine, in South Carolina, U.S.A., the rock formation is talcose slate. The soil is mainly the slate, disintegrated and decomposed. The slate is permeated by quartz veins, of all sizes, carrying gold. The soil is also auriferous. Particles of gold in the soil are all rounded, as if they had been submitted to attrition or solvent action; while those in the rock are crystalline in form, bright, and with sharp, well-defined edges. The gold from both positions is of equal quality, and the soil is of local origin. These facts seem to point to the present decrease of gold from the soil by solution, and increase, by deposition, of the gold in the rock.

Gold exists in natural auriferous materials in its native, or metallic, state, in irregularly-shaped pieces, from scarcely above the size of an atom to that of, say, a hundredweight. The larger pieces give no special trouble in securing after they are found, and do not call for our consideration in this paper. The smaller particles—those of which it takes thousands, perhaps, to weigh a milligramme—are the minute things which engage our present attention, and the efforts of metallurgists and electro-chemists the world over. The larger particles of gold are comparatively easily separated by amalgamation from the powdered auriferous rock, owing to their weight causing them to sink into contact with mercury surfaces; but the lighter particles float in the water used, do not come into contact with mercury, and are lost to amalgamation. Many efforts have been made to use electricity in obtaining this finely-divided gold. Most of them have been the dreams of unlearned enthusiasts, or the devices of dishonest men to obtain gold from the pockets of their dupes. The "Rae process," which has received so much consideration at the hands of "experts" in recent patent litigation involving the "cyanide process" of McArthur-Forrest, was an effort to simultaneously dissolve gold from ores and deposit it on a cathode by electrolytic action. It failed for at least two reasons: (1) the imperfect knowledge of electro-chemistry of its inventor; and (2) from the impractibility of causing the particles of gold to remain long enough in contact with the anode to be acted on electrolytically. The dynamos used by Rae at the Douglas Mill, in Nevada, about eight years ago, in the effort to gain practical results, were series wound, and without polarity protectors. Carbon anodes (sometimes, by reversal, the cathodes) were used, suspended in amalgamating pans, in which the pulp was agitated. The sides and bottoms of the iron pans were to be the cathodes. At least half the time they were the anodes. The mercury in the pulp was to combine with the precipitated gold and silver. By other inventors agitated mercury was made the cathode, and the fine gold was expected to mechanically "follow the current" into the mercury. Whatever of value the electric current conferred was due to the fact that there was a reduction at the cathode of oxides and salts of metals, thus keeping the mercury with a clean, bright, unoxidised surface, so that it was in a more receptive condition.

The amounts of various metals dissolved or deposited by a coulomb of current have been accurately determined. For example, one coulomb sets free 0·000162 grain of hydrogen. We may express this quantity as one hydrogen-coulomb = 0·000162 grain. From this we gain the following values:

One (dyad) copper-coulomb ... $= \frac{0{\cdot}000162 \times 63{\cdot}5}{2} =$ 0·0051035 grain of copper.

One (monad) silver-coulomb ... $= 0{\cdot}000162 \times 108 =$ 0·017343 grain of silver.

One (triad) gold-coulomb ..... $= \frac{0{\cdot}000162 \times 196{\cdot}6}{3} =$ 0·010611 grain of gold.

One (dyad) mercury-coulomb $= \frac{0{\cdot}000162 \times 200}{2} =$ 0·016200 grain of mercury.

One (dyad) iron-coulomb..... $= \frac{0{\cdot}000162 \times 56}{2} =$ 0·004536 grain of iron.

One (dyad) lead-coulomb..... $= \frac{0{\cdot}000162 \times 207}{2} =$ 0·016767 grain of lead.

One (dyad) zinc-coulomb..... $= \frac{0{\cdot}000162 \times 65}{2} =$ 0·005265 grain of zinc.

For a practical everyday-work unit, we may multiply each of the above quantities by 3,600 seconds in an hour to express the several quantities which an ampere will cause the solution and deposition of each hour. These quantities are as follows:

Hydrogen ampere-hour	0·5832	grain.
Copper ,, ...	18·37	grains.
Silver ,, ...	72·28	,,
Gold ,, ...	38·10	,,
Mercury ,, ...	58·32	,,
Iron ,, ...	16·30	,,
Lead ,, ...	60·36	,,
Zinc ,, ...	18·95	,,

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It has been found by experimenters in the line, and it may be accepted as a law, that the various elements bear a relation to each other, which relation we name "electro-positive" or "electro-negative," according to the method of expression. Some call it their "electro-chemical" relation. The electro-positive metals tend to composition with electro-negative elements. Thus, potassium is always electro-positive to the electro-negative oxygen. Elaborate lists of the electro-positive and the electro-negative elements are in the text-books. They have the order of arrangement which puts the most electro-positive first, followed, seriatim, by the less electro-positive, till at the lower end the most electro-negative element appears. But one element may be electro-positive to another element in one solution, while in another solution the electro chemical relation is exactly the reverse. For instance, in dilute sulphuric acid iron is electro-positive to gold; but in a solution of cyanide of potassium gold is electro-positive to iron. The electro-positive is always more soluble in the solution than is the electro-negative. If the electro-positive and the electro-negative metals be connected electrically while in the solution, the solving action of the liquid on the electro-positive metal is much increased—somewhat in proportion to the difference in their electro-chemical relation. Such a combination makes a galvanic battery more or less approaching perfection. The placing of an extraneous source of electricity in such a circuit may increase the action, or even reverse it, depending on the direction of the electric current. The dynamic value of these actions may always be measured as watts by suitable instruments, such as an ammeter and a voltmeter.

The facts that gold could be dissolved by chlorine, aqua regia, bromine, cyanide of potassium, etc., have been known for many years. These facts have been put extensively into practical use for the obtaining of gold from ores by means of chlorine gas, in the Plattner process, and its modifications. From the solutions so obtained the gold is deposited by ferrous sulphate ($FeSO_4$). For one reason or another, not necessary to consider here, electrolytic precipitation of the gold from this solution of auric chloride ($AuCl_3$) has not been practised in the art. Electro-gilding, using gold anodes and various metallic objects as cathodes in an electrolyte consisting of auro-cyanide of potassium (KCyAuCy) in a solution of potassic cyanide (KCy), has been practised for about 50 years. Its details are too well known to need consideration here.

We will consider the subject in its bearing upon the obtaining of gold from auriferous rocks and ores. For this purpose the most important solvent in practical use at present is cyanide of potassium, measured by the production of gold from the mines by its means. It has been stoutly asserted that cyanide of potassium is not a solvent of gold, and more surely maintained that it is, by reason of its extensive use for the purpose, spite of the fact that pure solution of potassic cyanide in water will not dissolve gold at a practicable rate, if at all. If, for an experiment, we take a piece of gold leaf and lay it on the surface of a cyanide solution, we will find that it will there be dissolved in a few minutes (the stronger the solution the more rapidly), while a like piece sunk in the solution will be hours in dissolving, the strength of the solution affecting the rate but slightly. It is claimed, and justly too, that the presence of oxygen is necessary for the hastening of the solving action, or rather the combination of cyanogen with the gold, so that the resulting auric cyanide be dissolved. This fact was recognised upwards of 50 years ago by Elsner, and the chemical equation was expressed by him thus:

$$4Au + 8KCy + O_2 + 2H_2O = 4AuCyKCy + 4KOH;$$

the oxygen in this case furnishing the necessary element to decompose some of the potassic cyanide so as to form the double salt, auric-potassic cyanide and pottassic hydrate.

MacLaurin, a New Zealand chemist, has proved with mathematical precision the truth of Elsner's equation. His admirable research was published more than a year ago in the *Journal* of the Chemical Society, London, 1893, p. 724.

Gold leaf of the same thickness and very nearly the same weight was allowed to remain—

	In stoppered bottle. 92 hours	In openbottle. 68 hours	In bottle with O. 96 hours
Water	125 grm.	125 grm.	125 grm.
Potassium cyanide...	1 grm.	1 grm.	1 grm.
Gold	0·9947 grm.	0·99035 grm.	0 99425 grm.
Loss of gold	0·0018 grm. = 0·18 %	0 09175 grm. = 9·1 %	0 23995 grm. = 24·2 %

The minute quantity of gold dissolved in the stoppered bottle is apparently due to a small quantity of oxygen previously absorbed by the cyanide solution from the atmosphere. Just in the same way water, though not a solvent for calcium carbonate, will dissolve the latter to some extent if not previously freed from carbonic acid by boiling.

Recognising the apparent necessity of the presence of oxygen, many experimenters have tried many oxidising substances besides passing air through the cyanide solution—such as peroxide of manganese, ferricyanide of potassium, bleaching powder or other materials yielding chlorine, bromine, and iodine, peroxide of sodium. I have tried peroxide of hydrogen with success. All these are more or less effectual in hastening the solvent action; but, as they have to be added in quantities far in excess of the amount theoretically necessary to effect the reactions, if actually brought into contact with gold and nothing else, they are wasteful, because they decompose more of the cyanide than is necessary for solvent action. Bromine, chlorine, etc., are simply oxidising agents—secondarily, to be sure, but still decomposers of the cyanide in too great quantities, because they exert their action away from the particles of gold. These oxidising agents have been tersely called "cyanicides." Their actions, direct or otherwise, are practically those of oxygen.

Be that as it may, in practice the finely-divided auriferous rock, or ores, is submitted to the action of successive quantities of aqueous solutions of cyanide of potassium, containing varying quantities of oxygen, or oxygen-producing materials, or analogues, in large vats, as in infiltration and percolation. Each quantity of the solvent is allowed to remain for a greater or less number of hours in, and covering, the ore, and is then drawn therefrom into precipitation vats, where the gold is obtained from the solution by various means, which we will presently consider. Generally, the finely-divided auriferous materials are "tailings" from the gold-amalgamating mills, which crush and treat with mercury the material for obtaining the contents of gold by amalgamation as far as possible.

These tailings contain extremely fine-divided gold which has resisted amalgamation, and in varying quantities, averaging about five to six pennyweights per ton of tailings. Any economy in the above process, such as hastening the rate of solving the gold; prevention of decomposition, as far as possible and feasible, of cyanide; making the gold more easily and cheaply obtainable from the solution, etc., is of vast importance in the metallurgy of gold.

Looking at the matter from the electro-metallurgist's standpoint, some time ago I concluded that the action of oxygen was due to its strong electro-negative relation to gold in a cyanide solution. Therefore, I tried the effects of various materials which are electro-negative to gold in solutions of cyanide of potassium. Carbon in contact with gold in cyanide solutions forms with it a voltaic couple, and the gold is far more rapidly dissolved than when alone. The best practical application of this fact is to finely powder the carbon, and continually agitate it with the auriferous tailings in a cyanide solution. Though the finely-powdered carbon causes more speedy action than do a few, or more, large pieces, it is still an operation of chance, because the increased rate of action is dependent upon actual continued contact of gold and carbon until the gold is dissolved. Iron is electro-negative to gold in a cyanide solution. The two form a galvanic or voltaic couple, and the action is the same as in the case of the carbon, only less in speed, because the iron is not so strongly electro-negative as is the carbon. I have discovered that mercury is electro-negative to gold in a solution of cyanide of potassium. I have availed myself of this fact to improve the cyanide solvent after this manner: I add to the cyanide of potassium solution used for the purpose, in any of its strengths (which latter vary from 0·01 to 0·5 per cent. of cyanide), a small quantity of potassio-mercuric cyanide ($2KCyHgCy_2$), say, 2oz., or more, per ton of solution. The action is as follows: the electro-positive gold decomposes the mercuric cyanide, taking to itself the cyanogen thereof, and receives on its surface the liberated mercury which amalgamates it. Then in the solvent there is the contact of a voltaic couple, under which condition the electro-positive gold is dissolved, and afterwards the extremely attenuated film of mercury again dissolves in the cyanide solution, to react as before. There are no combinations, decompositions, and reactions taking place, except those noted as being caused by the voltaic couple.

There are no oxidations of cyanides to cyanates, which latter are not solvents of gold. The solving action takes place very much speedier, because the electro-negative material is brought into, and retained till dissolved in direct contact with, the electro-positive gold. There is no deleterious material introduced to the solvent, and the mercury acts as an assistant in the subsequent operations of obtaining the gold from the solvent. In the older process two, three, or more changes of the solvent were made, with intervals between, during which the oxygen of the air was permitted to permeate the mass of tailings, and thus furnish the necessary electro-negative material. By my electrolytic process the necessary electro negative material, mercury, is always present, so that the solution may go on uninterruptedly so long as the necessary solvent, cyanide of potassium, is present in contact with the couple. But in order to ensure this condition, especially with extremely weak solutions of cyanide, the use of which is desirable, the solvent must be kept in motion through the mass, so that the part containing the cyanogen constituent which should be in contact with the gold may continuously replace the solution which has acquired its quantum of gold.

Pursuing the above plan, extremely weak solutions of cyanide of potassium may be used—say 0·01 per centum, or less—by percolating them through the mass of tailings continuously, and simultaneously passing the solvent from the percolator through an electrolytic bath with sufficiently extended electrode surfaces, and enough amperes of current to ensure the electro-deposition of the dissolved gold from the solvent wholly, or in greater part. The solvent can be returned continuously to the tailings to dissolve more gold, if necessary; or, if practically all the gold has been removed, it may be passed to a fresh lot of tailings, to again be passed through the cycle of operations.

The most extensively pursued plan of obtaining the gold from auriferous cyanide solutions is by precipitation by means of zinc. Practice has demonstrated that for effective deposition the zinc must be finely divided, and its surface must be bright and metallic, free from oxide or salts. Therefore the "zinc shavings" are always freshly prepared before the time of use. They are put in boxes having bottoms of iron-wire netting, and these boxes are so placed in the precipitation-vat that the solution enters each box of the series through the bottom, up through the mass of

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zinc shavings, down again, and up through the next box of the series. Having passed through the last box, much of the gold will have been deposited by auto-electrolytic action, and the solution, after being strengthened by the addition of more cyanide, is used to dissolve more gold, as before.

The electro-chemical action is as follows: The electro-positive zinc takes the cyanogen from the relatively electro-negative gold to form zinkic cyanide, which dissolves in the solution, setting free the gold in a finely-divided metallic condition. If the action would stop there this process would not be so objectionable. But owing to the voltaic couples formed by the zinc and gold, there is a further decomposition of the solution, with the formation of oxy-cyanate of zinc, zincate of potash, potassic hydrate, etc. Much of the deposited gold, becoming separated from electric contact with zinc, is redissolved by the cyanide, to be again deposited by more zinc. So it is practically impossible to precipitate all the gold by this means. If the necessary actions could take place in true electro-chemical equivalents, according to our table, 31·5 troy ounces of zinc would only be requisite to deposit 65·55oz. of gold. Instead of that, the practical amount, owing to the above-described wastes, and others, is about in the proportion of 1,750 troy ounces of zinc to obtain 65·55oz. of gold—over 50 times as much as should be necessary. There is something like a corresponding loss of cyanide of potassium. These wastes I have gathered from the data furnished by Eissler in his paper on the "Cyanide Process, etc.," read before the Institute of Mining and Metallurgy on November 21, 1894. Free alkali, or an alkaline condition of the cyanide solution, is desirable during the solvent action on the auriferous material; but it is undesirable in the zinc precipitation on account of its solvent action on the zinc, and its tendency to tarnish the zinc so that the auric cyanide may not readily act on it. On that account the smallest possible amount of alkali is used, when more would be desirable in the solving stage for decomposing metallic salts, etc., in tailings. When the depositing vats are cleaned up the precipitated gold is much mixed with pieces of zinc, insoluble zinc salts, etc. After careful drying, the zinc and gold slimes are treated by oxidising and smelting processes to secure the gold bullion, which is far from fine—say, 700 out of a possible 1,000.

With the object of overcoming the enumerated troubles, and other disadvantages, several experimenters have devised—on paper, at least—electrolytic processes for obtaining the gold from cyanide solutions. So far, the most successful one in extensive practice is that known as the "Siemens and Halske process," which is described in a paper read by Von Gernet before the South African Metallurgical Society some months ago, in the before-mentioned paper by Eissler, and one by Butters and Smart hereinafter noted. From these I gather the following facts: The cyanide solution is treated in four electrolytic vats, each measuring, approximately, 20ft. by 4ft. by 8ft., containing, alternately arranged, anodes and cathodes, which measure each 4ft. by 8ft., and are placed so that the solution in flowing through the vat moves downward on one side of each electrode and upwards on the other side, or are so arranged that the solution moves upwards by both sides of several electrodes, and downwards by a like number, serially, thereafter. The anodes are plates, or sheets, of iron, enclosed by canvas, and the cathodes are thin sheets of lead, supported in and by wooden frames. The current of electricity is caused by a dynamo taking 5 h.p. mechanically, and yielding 3½ h.p. in electrical energy at four volts pressure. (Von Gernet says four, Butters and Smart say 10, while Eissler says seven.) According to these data, the electric current may be $\frac{746 \times 3\frac{1}{2}}{4} = 652{\cdot}75$ amperes. The amount of iron used was 1,080lb. in one month, and the amount of gold deposited in that time was 697oz. 15dwt. 15 grains. The resulting products are the above amount of gold, some Prussian blue, ferric oxide, hydrogen, and an amount of impure litharge (PbO) from the cupellation of the lead cathodes; but nothing except the gold is of any economic value, because of the expense of reducing the other products to reworkable conditions. The facts about this process furnish an excellent text for a detailed consideration of the principles involved in the electro-deposition of gold. To begin at the beginning:

The Vat, or Depositing Vessel.—It is rightly made large, so that it may contain sufficiently extended surfaces of electrodes. It is made of wood, which sufficiently resists any deteriorating action of the electrolyte used in it. The electrodes are rightly arranged so that as the electrolyte passes through the vat, from end to end, it may come, as far as possible, into actual contact with the surfaces of the electrodes. Whether the surfaces are large enough depends upon the amount of electrolyte which passes through the vat in any unit of time, and whether, in its motion, it is brought actually, molecule by molecule, into contact with the electrodes. From the statement of the amount of gold—4dwt. 8 grains per ton of solution—remaining in the electrolyte after passing through the depositing-box, we may doubt the sufficiency of exposure to contact. The cathode surface is stated by Eissler to be 1,566 square feet. But, as it is evident from his other figures that he only took into account one side of the cathodes, the actual surface is 3,132 square feet. This is for one of four "precipitation" or depositing vats; so we have 12 528 square feet of lead surface, upon which were deposited 697oz. of gold in one month This statement of cathode surface agrees closely with that stated by Von Gernet and by Butters and Smart in a paper on the cyanide process read by the latter two before the Institution of Civil Engineers, February 19, 1895. The iron anode surfaces are $89 \times 7 \times 3 \times 2 \times 4 = 14{,}952$ square feet, from which we must deduct $7 \times 3 \times 2 \times 4 = 168$ square feet of surface of the end plates not presented to an opposite cathode. The anode and cathode surfaces are about 1½in. apart. On the whole, the mechanical construction of the vat and the arrangement of its parts seem to have been carefully considered, and to only err in the amount of electrode surfaces being too small for the actual electrolysis which takes place. The effective or commercial electrolysis is a very much less quantity, as we shall presently see. Von Gernet says that a better effect is produced by doubling the surface of electrodes than by increasing the current tenfold.

The Electrolyte is, of course, the solution of gold in a liquid composed of water, carrying also small percentages of potassic cyanide, potassic hydrate, and various compounds of cyanogen with metallic substances previously existing in the ore which had been treated by the solution, now the electrolyte. By the action of the electric current some ferro-cyanide of potassium is formed in the electrolyte, though much of this is converted into Prussian blue by contact with the oxide of iron formed on the iron anodes. The obvious improvement to be made is avoidance of any iron actions and reactions, because some of them consume electrical energy. The electrolyte is a weak solution at best, and, therefore, specifically, a poor conductor; but as the quantity is at all times large, the cross-section being 6,000 square feet, and length between electrodes but 1·5in., the resistance is practically nil, and need not be considered. The main consideration as to resistance to E.M.F. is that offered by the counter E.M.F. of polarisation. The oxide of iron formed on the anodes and in the pores of the bags drawn over them is, as a matter of resistance pure and simple, of some importance.

The Anode is composed of sheets of iron ½in. thick, exposing in the four vats 14,784 square feet to electrolytic action. Each of the 356 iron plates is "cased in canvas to retain the small quantity of Prussian blue produced (Butters and Smart), but also to retain the large quantity of ferric oxide produced. Von Gernet and Eissler state that the object of the "canvas is to prevent short-circuits" This last is an obvious precaution and result, owing to the close proximity of anode and cathode. We gather from the papers cited that an iron anode has been adopted after trying both carbon and zinc. Eissler says: "Carbon could be used as an anode, but it will not withstand the action of the current, and soon crumbles into a fine powder which decomposes cyanide. This finely-divided carbon is in suspension, and cannot be removed from the solution by filtration." Weightman states that he has "been using 'good arc lamp carbons,' and carbon in other forms, for the last six months, and they are still in excellent condition." Von Gernet says in his paper on the subject read last October before the South African Metallurgical Society at Johannesburg: "Zinc used as an anode forms a white precipitate of ferro-cyanide of zinc by the reaction of zinc oxide upon ferro-cyanide formed during the leaching. Similarly, iron anodes form Prussian blue by the reaction of oxide of iron and ferro-cyanide."

Let us consider these anodes. Owing to the fact that there must be an analysis (decomposition) of the electrolyte at the anode, electric energy is absorbed, or rendered latent, there; and if the material of the anode does not combine with the anion set free, to form a compound therewith, that energy is lost. Generally, and in this case, oxygen is directly or indirectly the anion, and as it cannot combine with a carbon anode, for instance, it escapes from the anode to the air as gas. The carbon anode is practically chemically unacted upon by the oxygen anion, but is mechanically disintegrated thereby, and the more rapidly the greater the current, and therefore of the escape of gas. Carbon is objectionable as an anode pure and simple, because of these two properties. But it is further objectionable because the oxygen, reacting on the potassic cyanide, forms potassic cyanate, which is inoperative as a solvent of gold. So, not only is the energy lost, but also the active ingredient of the electrolyte, making it inoperative as a subsequent solvent. Von Gernet's statement as to zinc is not clear. A very little ferro-cyanide should be formed during the leaching process. More likely the "white precipitate" is an insoluble coating of zinc oxy-compounds with cyanogen formed on the zinc anode. This coating offers great resistance to the E.M.F., so that it has to be increased to pass the necessary current; and this in its turn increases the difficulty, Much oxygen is set free, causing the corresponding wastes. So far, we now have only the iron anode to consider, as it has been adopted, and is used, at the mines. Practically, the iron anode is oxidised by reason of the current, and it takes a definite amount of electric current to oxidise a definite amount of iron; the iron-ampere-hour being 16·3 grains. The amount of iron used in the month of August was 1,080lb. This equals $1{,}080 \times 7{,}000 = 7{,}560{,}000$ grains. Providing this was all oxidised, the ampere-hours were $\frac{7{,}560{,}000}{16{\cdot}3} = 463{,}803$. According to Von Gernet, the amperes were produced by four volts; therefore there were in a month $\frac{463{,}803 \times 4}{746} = 2{,}487$ horse-power hours. The electric energy was 3½ h.p.; therefore was used $\frac{2{,}487}{3{\cdot}5} = 710$ hours, in a month of 31 days, or 744 hours—a curious coincidence. But Eissler says the pressure was seven volts, and Butters and Smart say the dynamo used gives 300 amperes at 10 volts. These latter statements, taken with the probable conditions that there are undoubtedly some wastes of iron in the way of unoxidised scrap, and possible intermissions in current, are probably nearer correct. Taking 300 amperes for 700 hours, we have an oxidation of iron $\frac{300 \times 700 \times 16{\cdot}3}{7{,}000} = 489$lb, and a scrap of waste of $1{,}080 - 489 = 591$lb. Evidently we need some more exact information for theoretical considerations. For this

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current — assuming the minimum statement be correct — 300 amperes, the gold deposit was 697oz. 15dwt. 15 grains = 335,935 grains. According to our gold-ampere-hour equivalent of 38·1, this quantity requires 8,817 ampere-hours to deposit; but to do this $300 \times 700 = 210{,}000$ ampere-hours were expended—about 24 times too much, if the proper association of materials had been made so that all the economic actions went on in the electro-chemical equivalents to the gold. Upwards of 200,000 ampere-hours were expended in decomposing water and setting free hydrogen.

The Cathode is of sheet lead. It was adopted, according to Von Gernet, as best satisfying the following conditions: "(1) The precipitated gold must adhere to it. (2) It must be capable of being rolled out into very thin sheets to avoid unnecessary expense. (3) It must be easy to recover the gold from it. (4) It must not be more electro-positive than the anode, in order to prevent return currents being generated when the depositing current is stopped. The most suitable metal for the purpose is lead . . . and meets all the requirements of the case." These four requirements are very good, and should be, with others, carefully attended to. There is no exception to be taken to the first within practical bounds. To the second, we say the cathode should be as thin as is consistent with mechanical stability, and most assuredly as thin as possible when wasted absolutely, as it is in practice, at the rate of 750lb. per month, in a small plant. A far better cathode is one which does not deteriorate, and practically is not wasted at all. To the third, we say that it is not "easy" to recover the gold from the lead cathode. The necessary melting and cupellation is an expensive process—much more so than is the recovery of gold from the amalgam from a mercurial cathode, by distillation, or "retorting," as is continually practised in the metallurgy of gold. To the fourth, we say that a lead cathode is more electro-positive than an iron anode in a cyanide solution, and, therefore, does not fill the requirement. Furthermore, as soon as the lead cathode becomes coated with gold it becomes a gold cathode, which is electro-positive to the iron anode, therefore defective so far as this requirement is concerned. According to Von Gernet, a mercury cathode has been tried, but is impracticable on account of the large amount necessary to carry on the operation—say 80 tons to a small plant. "Sheets of solid metal (as copper) coated with mercury have also been tried, but have been unsuccessful, because the mercury, owing to the action of the current, will penetrate the copper and form a dry amalgam, which does not adhere to the plate." The mercury does not penetrate the copper plate any sooner than it does in the ordinary copper-plate amalgamation of the gold mills. That it forms a "dry" amalgam with the small amount of mercury which a vertically-placed copper plate will alone retain is evident. But the copper-plate cathode could be occasionally re-freshened with mercury by sprinkling to the extent of keeping the amalgam plastic, but not so thin as to run off. I prefer to furnish the mercury necessary on a copper-mercury anode by the direct electro-deposition of mercury with the gold from the electrolyte.

The Current.—This is variously stated by the different authors quoted as from 300 to 600 amperes with pressures of from ten down to four volts. Without unnecessary wastes, the current sufficient to deposit 697oz. 15dwt. 15 grains, equal to 335,935 grains, of gold in 700 hours is $\frac{335{,}935}{700 \times 38{\cdot}1} = 12{\cdot}6$ amperes. Von Gernet says: "In a fixed time a given electric current will deposit a certain quantity of metal, which quantity varies for different metals in direct proportion to their electro-chemical equivalents. This law holds good only for solutions strong in metal; but with dilute solutions, as in use in the cyanide process, the current does not find sufficient of the metallic compound present at the electrodes, and consequently decomposition of water also takes place. For this reason, to make the efficiency of the precipitation as great as possible, constant diffusion of the solution is requisite." This explanation contains the essence of the whole matter. The efficiency is only from $\frac{12{\cdot}6}{600} = 2{\cdot}1$ per cent., to $\frac{12{\cdot}6}{300} = 4{\cdot}2$ per cent. In most of industrial operations we would consider such efficiences exceedingly low. The waste of energy to produce the current, the waste of cyanide to produce Prussian blue, the waste of iron to make oxide and Prussian blue, the waste of lead to produce oxide of lead, and the waste of labour in handling these unnecessary quantities, add to the necessary expense of electrolytic treatment of auro-cyanide solutions at least £130 in a 3,000-ton per month plant, or 10·4d. per ton.

It will be asked, "Why these wastes, and can they be avoided without substituting others equally as expensive?" These expenses are due primarily and mainly to the improper selection of electrodes. The anode should be soluble under the electric current in the electrolyte in which it is immersed for at least two reasons: (1) that it may communicate to the circuit the energy due to the combination of the metal of the anode with the anion; (2) that the compound thus formed may be removed by the electrolyte to expose a fresh metallic surface for the continuation of the operation in regular progression.

Iron is not soluble in cyanide of potassium solutions. It is, as I have before stated, strongly electro-negative in such solutions to all other metals which may be met with in the operation. The anode should be electro-positive to gold. Copper is so, but it would enter the solution at the expense of the cyanogen. Besides, it would be deposited on the cathode after a time and render the gold impure. Carbon is not suitable, because in the cyanide it causes the formation of cyanate, and, besides, it is strongly electro-negative to a gold cathode. Zinc is electro-positive to gold in the electrolyte, but, as before stated, there forms upon it an insoluble coating impenetrable to moderate voltage of electricity. With iron it is necessary to raise the pressure of the current to overcome the resistance of the oxide and Prussian blue on its surface. But if it be arranged so that the anode be soluble, the current may be of very low voltage; and even it may contribute energy to the circuit. The way to secure this desideratum is to provide an electrolyte for the anode which will promote its solution. To do this, the selected electrolyte must be mechanically separated from the cyanide electrolyte. This can be done by the use of porous cells, such as are used in various of the forms of galvanic batteries. The electrolyte in the porous cell, for convenience called the anode-electrolyte, must be of such a composition that the accidental mixture of it with the cyanide solution, for convenience called the cathode-electrolyte, will not injure the latter, nor confer upon it deleterious qualities. Such an electrolyte is found in aqueous solutions of ammonium salts, such as the chloride, bromide, and sulphate of ammonium. Zinc or iron anodes placed in such electrolytes, in porous vessels immersed in the cathode electrolyte, will be readily dissolved, by reason of the formation of soluble double salts of the metal with ammonium.

With an iron anode in the cyanide solution it is necessary to raise the voltage to cause the current to pass the oxides, etc. In doing so there is an evolution of much free oxygen, with corresponding loss of electrical energy. But that is comparatively a minor defect. It also sets free a corresponding amount of hydrogen at the cathode. These two gases accumulate, each on its appropriate electrode, until their comparative levity causes them to escape against the pressure of the electrolyte. But they continually cover a very large part of the electrode surfaces, and thus keep from them the electrolyte, which should be in contact therewith. If this action be prevented, the electrode surfaces need not be nearly as large for the same amount of deposition of gold. In order to force the deposition, then, the voltage is raised to from four to ten volts, though one-quarter of a volt is sufficient to produce the necessary actions and reactions under proper assemblages of materials as to quality, size, and position. If the analysis (decomposition) and synthesis (composition) be equal, no energy is absorbed other than to overcome the resistance. As the resistance is small, owing to the large cross-section of electrolyte and small distance between electrodes, a very small E.M.F. is necessary when the proper electrode and electrolyte for it are used. Take such an assemblage, and the work of depositing 97oz. of gold should be done with the expenditure of $12{\cdot}6 \times 0{\cdot}25 = 3{\cdot}15$ watts, for 700 hours, instead of $300 \times 10 = 3{,}000$ watts for the same time.

If iron had been used in a proper electrolyte, the iron dissolved would have been as 65·5 : 28 : : 697 : 298oz. of 480 grains, equal to $\frac{298 \times 480}{7{,}000} = 20{\cdot}4$lb., in place of 1,080lb., a saving of 1,060lb. But iron would have used, say, about 40lb., including waste, of ammonium sulphate in the anode-electrolyte—worth about 55 pence.

If zinc had been used in a suitable electrolyte, the amount would have been 65·5 : 32·5 : : 697 : 345oz. of 480 grains, equal to 23·6lb., with a like consumption of ammonium salt. By the direct zinc precipitation in the McArthur-Forrest process, according to Eissler, there is a consnmption of zinc varying from 0·25lb. to 0·50lb. per ton of ore—say, an average of 1,000lb. for the quantity of gold produced (697oz.) from 3,000 tons of auiferous tailings. There is in this item alone a saving possible of £18 sterling per month.

In the *Proceedings* of the Engineers' Club of Philadelphia for November, 1894, there is a paper, entitled "The Electro-Metallurgy of Gold and Silver," by A. L. Eltonhead, in which he describes an alleged proces of separating gold from cyanide solutions, said to be used in a "small plant" by "the electro-chemical process (patent applied for) on the west side mine of the Tombstone Mill and Mining Company, of Tombstone, Arizona." The writer of the paper was evidently not fully posted as to the process. and did not mention the name of the "inventor" (?). The description is somewhat vague and imperfect; but we gather that the "precipitating-box is of novel construction," is 10ft. long, 4ft. wide, and 1ft. high, divided into "five lengthwise compartments." "Under each partition grooves may be cut, a ¼in. to ½in. deep, extending parallel with the partitions to serve as a reservoir for the amalgam, and give a rolling motion to the solution as it passes along through the four [*sic*] compartments. The centre compartment is used to hold the lead, or other suitable anode, and electrolyte." "The electrolyte may consist of saturated solutions of soluble alkaline metals and earths. The sides or partitions of each compartment dip into the mercury, which must cover the 'box' evenly on the bottom to the depth of about a ½in. Amalgamated copper strips or discs are placed in contact with the mercury, and extend above it, to allow the gold and silver solution of cyanide to come in contact. The electrodes are connected with the electric dynamo, the anode of lead being positive and the cathode of mercury being negative. The dynamo is started, and a current of high amperage and low voltage is generated, generally 100 to 125 amperes, and with sufficient pressure to decompose the electrolyte between the anode and cathode. As the gas is generated at the anode a commotion is created in the liquid, which brings fresh and saturated solution of electrolyte between the electrodes for electrolysis, and makes it continuous in its action." There seems to be a distinction between the "electrolyte" and the "solution of double cyanide of gold and potassium"; but where they are separated and how, if at all, does not appear. There is a "half-tone" picture of the "box," but it gives no more

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information than does the above description. The anode surface is about 16 to 18 square feet, which can be made less by raising with thumb-screws. The cathode surface may be about 40 square feet. With a current of 125 amperes we should judge that "the gas creates a commotion," and such a commotion that it would be wonderful if the process be speedy, and otherwise than "continuous." From the principles involved, which we have considered, this "process" may be set aside. Yet it is but one of the many suggestions, or attempts, made by "inventors" (?) unacquainted with the electrical and chemical requirements. We have not the time to consider more of these within the limits of this paper. We know that oftentimes more is learned through failures than through successes, so we may consider these and the fallacies at some other time.

After thorough experimenting and test I have devised, and patented throughout the gold-producing countries of the world, the following described process for electrolytically obtaining gold and silver from auriferous and argentiferous rocks and ores: Sufficient solution of cyanide of potassium, of a strength varying from 2lb. to 10lb. of cyanide to each ton of water, with from 2oz. to 10oz. of a soluble salt of mercury, is prepared. The finely-pulverised ores, or tailings, are submitted to the leaching process with this solution, as in the other cyanide processes. The electro-positive gold in the tailings decomposes the mercury salt which comes in contact with it, and thereby produces voltaic couples of mercury and the minute particles of gold, thus hastening the solving of the gold. As the speed of solving is dependent upon the actual contact of the gold and mercury with the cyanide of potassium, it is preferable to keep the solvent in constant motion during the percolation, or leaching, so that fresh solvent, not exhausted of its cyanide, may continually be in contact with the gold. To accomplish this, the whole, or part, of the solvent is frequently drawn from the leaching-vats, or is continually passed through the tailings, until the solving action is completed. In this way much weaker solutions may be used than is the case where the cyanide solution is allowed to stand for long stated periods in the tailings. The weak solutions are preferable because the losses in material are not so great, and they are equally as good solvents as the strong, though not so speedy. As the solutions come from the leaching vats they are run continuously through electrolytic precipitating, or depositing, vats, constituted as follows: long boxes are provided, say, a little over 2ft. deep and 2ft. wide, containing copper plates 24in. square, and crossing the boxes every 1½in. to 2in., but placed so that every alternate plate rests on the bottom and sides of the boxes, and the intermediate plates are raised about ½in. above the bottom of the box. The number of plates and the length of the boxes are sufficient to permit of the deposition on them of all the metal constituents of the solution without so great a density of current that hydrogen is deposited likewise. If the solution be kept sufficiently in motion, the density may be 0·1 ampere per square foot of cathode surface; but as the solution becomes much weaker in metal towards the latter end of the vat or box, the density there cannot be so great. But this matter is self-regulating, because the greater tendency to polarisation impedes the passage of the current at the latter and weaker end. On the average basis of a density of current of 0·06 ampere per square foot, a cathode surface of 800 square feet is ample for a plant treating 3,000 tons of average tailings per month. One hundred plates of the size named supply this amount of surface. These plates are preliminarily amalgamated with mercury, and are each connected with a 'bus bar which is connected with the negative pole of the source of electricity. Between these cathodes are placed porous cells filled with a half-saturated, or other strength, aqueous solution of an ammonium salt, such as the chloride of sulphate. Into each cell is placed a rod, strip, or prism of zinc or iron, and each of these is conected by wire to another 'bus bar, which is connected with the positive pole of the source of electricity. The cyanide solution of gold and mercury is passed continuously through this vat, tank, or box, in a steady stream, and at a rate which ensures the deposition of a greater part of its metallic contents. If the quantity of mercury on the copper plates, together with that which is deposited from the solution, be not enough to keep the amalgam in a sufficiently plastic condition, more mercury solution may be added to supply mercury for that purpose. If it be too soft, the amount of mercury solution may be decreased. No mercury is lost, because recovered by the electrolytic deposition. Because the gold is deposited in exceedingly attenuated particles, the amount of mercury necessary to form with it a plastic amalgam is much in excess of the quantity of gold—say three or four times as much. This relations varies with the rate of deposition of gold. Take, for example, 12·6 amperes to deposit 1oz. of gold per hour, and 29 amperes to deposit 3½oz. of mercury in the same time, and we have the practical requirement of 41·6 amperes to deposit 1oz. of gold per hour. This for 744 hours per month is enough to more than deposit the 697oz. produced per month by the use of 300 amperes for the same time, in the case illustrated by the authors referred to hereinbefore. Because the anode is rendered soluble by putting it in a suitable electrolyte there is no consumption of energy in the actions which there take place. There is no escape of uncombined or free oxygen. A zinc anode is electro-positive to the mercury cathode to the extent of 0·25 volt—in itself sufficient to cause the deposit. When the anode-electrolyte has become exhausted as an electrolyte by the formation of double salts with the metal of the anode, the porous pots have their liquid contents removed and new electrolyte substituted therefor. Porous pots are used 1in. or so in diameter and 24in. deep; eight or ten in each space between the cathodes are sufficient. The cathode, though in its substance mainly of copper, is electrically a mercury one; therefore not as strongly electro-positive in its electrolyte as is a copper one. But the anode is sufficiently electro-positive to keep the cyanide solution from dissolving the gold and mercury when the dynamo or other source of electricity is unconnected, provided the anode and cathode be connected electrically. The depositing-vat can be, and is preferably, worked continuously. The anode parts are supplied from time to time as fast as dissolved. The anode-electrolyte is renewed from time to time, as necessary, by the use of a hand-pump. The amalgam is removed whenever desired from the cathode plates. For this purpose they can be disconnected from the 'bus bar one by one, removed from the vat readily, the amalgam scraped off, and the plates returned to the vat. There is, necessarily, no wholesale removal of electrodes, as, for instance, in the previous case, when the iron-plate anodes become full of ragged holes from corrosion, or when the lead cathodes were removed to be melted and cupelled. The amalgam is "retorted," as in the usual routine of gold amalgamation—a much simpler and less expensive operation than melting and cupelling. Practically no mercury is lost, but lead cathodes are lost. The E.M.F. necessary to carry out this process does not exceed one-half volt. Whatever there be more than that would be expended in decomposing the water of the electrolyte, thus unduly oxidising the anode, and setting free hydrogen at the cathode to no good effect, but rather cover the cathode with hydrogen films, and to that extent reduce the surface available for receiving the metal deposit, thus increasing the resistance and lessening the current. In the effort to increase the metal deposit by raising the voltage we would meet the same difficulty as is experienced with the said Siemens and Halske process, and find, as Von Gernet says, "a better effect is gained by doubling the surface than is obtained by increasing the current tenfold."

The expense of working 3,100 tons of tailings in August, 1894, at the Worcester Mill, in Johannesburg, by the Siemens and Halske process, as stated by Eissler, was, in detail, as follows:

	£ monthly.	d. per ton.
Filling and discharging leaching vats	125	10
Cyanide	75	6
Lime	15	1·2
Caustic soda	6	0·5
Lead	14	1·1
Iron	28	2·2
White labour	65	5·2
Natives' wages and food	20	1·9
Coal	57	4·6
Stores and general charges	41	3·2
Total	£450	3s.

By the improved electric process at least £130, or 10·6d. per ton, can be saved in expense in the following items: one-half of the cyanide, all of the lead and iron, 10 per cent. of the labour, and three-quarters of the coal. There would be wasted by the new process, say, 25lb. of zinc, worth at the mines about 19s., and about 5s. to 10s. worth of ammonia-salt—about 0·11d. per ton. The use of strongly-alkaline solvents is desirable during the dissolving stages of a cyanide process, because the alkali serves to decompose various salts and oxides, such as ferrous sulphate and oxide, ferric sulphate, and sulphates of aluminium and magnesium, etc., which would otherwise decompose the cyanide. But alkali is inadmissible when zinc precipitation follows, because of the increased waste of zinc caused thereby in the formation of zincate of the alkali. The alkali is inadmissible when chlorine, iodine, bromine, and such like "cyanicides" are used, because they expend their action on the alkali instead of where desired. By my electrolytic process the solvent may be very strongly alkaline without detracting from its desirable solvent action, but rather adding to its efficiency, and decreasing what would otherwise be the solvent action on other constituents of the ores.

At last night's meeting of the Institution the following candidates were balloted for:

Associates.—Henry Pem Bonus, 4, Claremont-gardens, Surbiton; Herbert Edward Keen, 21, Broad-street, Worcester; Joseph Ernest Petavel, 60, Kensington Gardens-square, Bayswater, W.; Robert Edward Phillips, M.I.C.E., 70, Chancery-lane, W.C.; Mansingrao Apasahib Solasker, 8, Zetland-terrace, Lansdowne-road, Old Charlton, Kent; William John Thomas, 3, Park-place West, Regent's Park, N.W.

Student.—Thomas Robert Robertson, 140, Douglas-street, Glasgow.

Discharge of Cargo.—The agents of the India General Steam Navigation Company, Limited, in Calcutta, bearing in mind the losses by fire occurring on steamers and flats, and with a view to minimise the risks run by working cargo on and off their vessels at night, have put in an electric light installation in their cargo godowns at Nimtollah, Calcutta. According to the *Indian Engineer*, the arrangement is such that the dynamos can be made to light any of the vessels working at night as well as the gangways and godowns. A Hornsby-Akroyd oil-engine supplies the motive power.

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TO CORRESPONDENTS.

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SUPERHEATED STEAM IN ELECTRIC SUPPLY STATIONS.

The proper management of electric supply stations is a subject which might be very properly discussed, but it is far too large to be dealt with in a short leading article. The development of the industry has now attained such large proportions that a special series of volumes are needed which should deal, not only with the management of the plant used for producing the current, but also with the financial aspect of the question, and also with the status of the various companies from a municipal point of view. There is, doubtless, very much matter scattered in the technical press dealing with this subject, but there are as yet, so far as we are aware, no such facilities for acquiring information as to costs of management and upkeep as are to be obtained in, for instance, the gas industry. The latter is, of course, a much older branch, and its literature has gradually grown up round it, and possesses the advantage of experience gained over a much longer period. There is no doubt that the difference between the condition of dividend payment and non-dividend payment depends very greatly upon the ability and experience of the resident engineer. The plant may in the first instance have been well selected for its work, and the distribution system may be as nearly perfect as experience can make it—in fact, the consulting engineer may have left the station in thoroughly fit condition; but if the maintenance be faulty the station may be unable to pay a dividend.

Changes are taking place in many of the metropolitan electric supply stations. The St. James and Pall Mall Company are advertising their smaller plant for sale, with a view of replacing it by larger units; at Deptford a new dynamo and engine have been put down, larger than any in use there before—this unit was built by the firm of S. Z. de Ferranti and Co., and is probably now the largest in the world. One of the chief objects of the engineer is to reduce the height of the peaks in his daily load curve diagram, and attain, if possible, something approximating to a straight line. With all the energy, both personal and electrical, which has been thrown into the question of cooking by electricity and working small motors by the same means, these peaks have not yet shown much sign of diminution. It is, therefore, well worthy of consideration whether some means cannot be found to deal with the existing order of things without waiting idly hoping for the time when the ideal load curve will be attained.

At present there are many sources of loss. For example, during the winter months it is impossible to predict at what moment a fog may settle down over the district supplied from a given station; therefore extra boiler power must be available at any moment. Until recently very little attention has been given to the important question of economy in the boilers; if the engines and dynamos gave a high efficiency, it was thought that all had been obtained which it was possible to secure, but now attention has been directed to the great losses in coal consumption entailed by the necessity for keeping a

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number of boilers ready to give off steam at a few minutes' notice. One of the most obvious methods of obtaining an increased output of steam for a short period is, of course, to force the boilers, but the unfortunate thing is that many types of boilers when forced give exceedingly wet steam, which means great danger to the engines, and if the methods of drainage for condensed steam on steam-pipes and engines are not perfect, there is a great risk of breakage of cylinders. If, however, some means can be found by which boilers may be forced and still give out dry steam, a great economy in coal should be possible, and certainly an increased efficiency obtained in the engines.

Superheating the steam is, doubtless, one method for effecting this economy, but upon this point a good deal of difference of opinion has hitherto existed, some persons maintaining that it is not possible to superheat steam without creating difficulties in the lubrication of the cylinder walls and in keeping the packing of the glands good. There are, however, various methods of superheating steam, and some of these are radically bad. We were led to consider this point by finding that for more than eighteen months past Mr. Patchell, the engineer of the Charing Cross and Strand Electricity Supply Corporation, has been experimenting with a system of superheating in the Babcock and Wilcox boilers at the supply station with very satisfactory results. The particular system employed is one which prevents the temperature of the steam being lower than the temperature due to the pressure in the steam spaces, and does not create the difficulties previously alluded to. We do not wish it to be understood that these boilers are worse than other boilers for causing priming when forced, nor do we wish to lay stress upon the particular method of superheating, but we firmly believe that very many stations which are now using a number of boilers as a stand-by during times of heavy load would find that their use might be discontinued if a suitable method of superheating the steam were installed. Such a system must increase the boiler power very greatly, and we commend the subject to the consideration of all engineers of central stations.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

PERMANENT MAGNETS USED AS MAGNETIC COMPASSES.

SIR,—In your issue of December 7, 1894, which has just come to hand, I read with some interest a descriptive account of the properties, etc., of a permanent magnet. I do not fear contradiction when I state there are few subjects known to scientific men that are less understood than permanent magnets and their source of power. It is the knowledge of this want of information that prompts me to subscribe this letter.

It is with the permanent magnet used as a magnetic compass that I propose dealing, and I hope, whatever may be said as to the merits or demerits of my theory, it will at least induce others to institute enquiries and make investigations as to the origin and source of the power that makes and controls the magnetic compass. The properties of the magnetic needle have been enquired into by men like Halley, Barlow, Faraday, and Walker, and to anyone who reads the works of these men it will be manifest that while they almost agree with one another as to the properties of the magnetic compass they differ considerably as to the source of the controlling power, or, rather, as to why a magnetic compass, when freely suspended, has a north and south seeking pole.

Among some of the theories set up was that the earth was either a vast magnet, or that there were large deposits of iron in the neighbourhood of the Polar regions. This latter theory was somewhat strengthened by Halley's discovery, or confirmation of discovery, that there existed on the earth's surface spots of equal maximum and minimum attraction to a magnet, or, in other words, that there were magnetic poles distinct from the earth's axis, and it was thought that this fact was consistent with the theory of iron deposits. About this time a careful examination of a series of experiments made with a magnetic compass in London showed that when a magnetised needle was freely suspended it was liable to several errors: (1) a horizontal variation of an almost constant quantity (slightly varying during a cycle of years); (2) a diurnal variation amounting to only a few degrees, but which was considerably affected by climatic and atmospheric changes; (3) a dip or tendency of the needle to assume a perpendicular position.

The only variation, however, which is taken into consideration in ordinary use of a compass is that first described above. All three kinds of variation are liable to considerable alteration in consequence of moving the instrument from place to place.

I have lately made a series of experiments with six needles, all most carefully made, measured, and weighed, and having on their north-seeking pole a vernier, and on the case of the instrument an arc, by which means I could read off any variation to a twelfth of a minute, or five seconds. All the needles were suspended on a single fibre of silk. I noted that no two of the needles would lie in the same meridian, some varying to the east and others west; while out of a series of changes and a series of observations covering several weeks, I found that on each series of observations the mean of the six needles was always the same. From these observations I came to the conclusion that there was some variation peculiar to each needle. Upon a subsequent examination of the needles, I found (1) that four of the needles were not of an equal hardness throughout; (2) that upon dropping fine iron filings on a paper over each of the needles, I found that the lines of force were in the case of the four needles more or less one-sided, showing beyond a doubt that there was an error in the needle, and on referring to my notes of observation, I found that the greatest magnetic difference was in the case of three of the four faulty needles.

As to the cause or source of magnetism, I must quote from Prof. Barlow's work, in which it is suggested that the action of a magnetic needle in having north and south seeking poles was due to a constant thermo-electric current flowing round the earth produced by the hot rays of the sun acting upon the molecules of the atmosphere.

Prof. Barlow made an experiment with a wooden sphere having a wire passed round its equatorial girth. Then passing a current of electricity along the wire produced an effect upon a magnet needle suspended over the sphere which was made to revolve on its own axis, as does the earth, with the result that he reproduced on his compass nearly all the variations to which it is subject terrestrially. I think that it may be reasonably claimed that if a current was at all times passing round the earth equatorially, all the variations of the compass would be fully accounted for. Though I agree with Barlow as to the presence of the current, I do not agree with him as to its source being due to heat of the sun. I rather choose the theory that the earth is to the sun what an armature is to a field magnet in a dynamo, and that the constant revolution of the earth against the heated surface of the sun sets up a current of electricity similar to that set up in an armature of a dynamo.

Let us assume that there is a current, however produced, passing round the earth's equator. Now, it is well known that electricity always passes along a conductor best able

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and most suitable to carry it, and as it can be readily be understood how the earth's surface undergoes considerable alterations from season to season, month to month, week to week, and even day to day, so that part of the earth's surface, acting as a good conductor one day, may, by some climatic change, be made only an inferior conductor the next, and so cause the current to travel more or less out of a direct path. And this frequent change of the path of the current would account for the annual, monthly, weekly, daily, and even hourly change in the variation of a compass needle.

Now, as to what magnetism is, the writer of your article has suggested a theory of magnetised molecules, each being a perfect unit. This suggestion, far from being new, is the one most generally adopted—*vide* page 122, "Text-book of Science," 1874, by F. Jenkin, L. and E., M.I.C.E., etc. My own interpretation is that all substances are positively or negatively magnetic, and that all active magnets must have those two properties in combination. I will take as an example a rod of steel, and will describe it as containing a certain amount of latent magnetism, either positive or negative. And in order to render the rod an active magnet it will be only necessary to introduce into its composition an equal amount of opposite magnetism to that which it already contains, as by placing it near a fully-developed magnet or by rubbing it with one. Then what takes place is that the overflowing lines of force in the developed magnet passes into the steel rod and causes the dormant or latent magnetism of the rod to change into active form. And the longer the two are together the stronger will the rod become until it is developed to an equal degree, after which each magnet, being fully developed, will add to or sustain the power of the other until both are raised to a certain maximum.

The reason why the rubbing of one end of the rod with a magnet will cause it to be developed by an opposite force is that the rod had already a charge of latent magnetism containing all the elements of a magnet, but required the presence of either an excess of positive or negative force to start the whole into life. Consequently, when an excess of, say, the *north* or positive pole is introduced, its affinity is to attach itself to its reverse, and so create a south pole in the rod. Thus, once having developed in the rod a molecule of fully-developed magnetism, that molecule would at once transmit its now complete force to every other particle, until every particle in the rod was affected, and that being done they for all time counterbalance one another. And as both cannot act the same way at the same time, they take opposite ends or poles; and if there are no extremities, as in, say, a sphere, then there is no magnetism, because the latent power cannot find a suitable mode of dividing itself when separated from the magnetising magnet.

I will not say any more, as I think I have already occupied too much space, but I shall be glad some day to give you accounts of a number of experiments made by me and the deductions I draw.—Yours, etc.,

ARTHUR FOSTER SMITH.

Ludstone-chambers, 352, Collins-street, Melbourne,
February 2, 1895.

TESTING INSTRUMENTS.

SIR,—I note Messrs. Elliott Bros.' letter in your last issue. They make no reference to their attempted piracy of my patented apparatus, an additional proof of which I have before me in the form of a signed quotation for same. They, however, make an unfair and futile effort at a *tu quoque* reply, and taking one of several pamphlets issued by me, entitled "The Ayrton-Mather Galvanometer and its Accessories," they claim my wood-cuts (Figs. 5 and 6) as *their* original designs, without mentioning that these represent an ordinary wooden scalestand and shunt-box. These, as they naïvely admit, have been well known for 25 years. Indeed, they have been manufactured by all makers of testing instruments.

Though Messrs. Elliott Bros. were informed on the 4th inst. that my list No. 2 of 1892, being out of print, could not be sent them, their letter is so worded as to create the impression that they are criticising my general list. I told them that I hoped shortly to forward them copy of my new catalogue, for which some 60 or 70 original wood-cuts have been prepared, chiefly of instruments designed or perfected during the last few years.

I can assure you I have the greatest horror of flattering them, as they suggest, by any imitation of their methods.—Yours, etc.,

ROBT. W. PAUL.

London, March 9, 1895.

WHAT IS HEAT?

SIR,—My attention has been drawn to your review of my book in your issue of the 1st inst. As I feel that you have unconsciously done me some injustice, will you allow me to correct the mistake? Your reviewer states, "We must also suggest that in this book are many statements, which are not proofs, and the author is as dogmatic as any of those he criticises." Your reviewer has evidently overlooked the following statement in the book (page 37), which is the key to the position I have assumed. I feel sure that you will exonerate me from being dogmatic after your attention has been drawn to the sentence:

"As we can obtain, therefore, no real help from the metaphysician or mathematician, we proceed by other methods. We shall endeavour to give a graphic picture of the atoms and molecules, their physical constitution, their motions, and their general reactions. We shall propound an hypothesis, and shall assume that it is true, not that we wish to approach these great fundamental questions in a dogmatic style—this is farthest from our thoughts, but we have a very difficult task, and we have to bring the issues before the reader in the very clearest manner. This, we think, is best done in the way a barrister pleads his case in defence of his clients, and, like him, we shall assume our case is 'pure'—that it is the truth. We shall so state it, and we shall bring powerful evidence to prove that it is so, because we believe that it is the whole truth and nothing but the truth, and we shall place the onus upon our opponents to prove our case false. Although we shall for the sake of debate assume this position, we add it *is an assumption only, and the most we can say is we hope we have stated the truth.* We believe this: If we have not succeeded in stating the truth, we have done something to advance it, and this will be a gain."

Your reviewer acknowledges this result in these words: "This book contains much that is interesting, much that ought to lead to thought, much that is true, many very excellent and instructive experiments." Therefore all I aim at is achieved.

Then your reviewer twits me with falling foul of the mathematician. It was absolutely necessary I should do so. Of positivists, the mathematician is the most positive, and I found, practically, that if I had not introduced the fundamental errors in mathematics the reply would be: whatever is proved experimentally and is against mathematical ideas, mathematics can prove that in such cases experiment is false. And bear in mind I have been very careful to safeguard myself with quotations from the most able writers and thinkers. It is difficult to believe the trouble I have had to avoid the course I have most reluctantly taken. If I were to show you the evidence of contempt and repulsion given to me by the scientific world, you would cry shame against a set of men who pose as pioneers in the progress of human thought. Now, take the example of six objects multiplied one-half times, neither experiment can perform the operation nor the mind can grasp the operation. The view is not peculiar to myself, and this I show in the book. Thus Hall and Knight, in their "Elementary Algebra," state: "The definition of multiplication, in the strict sense of the word, supposes that a quantity is to be added to itself a certain number of times; but when the multiplier is a fraction, this definition ceases to be intelligible." The fundamental error arises thus: algebraists state a multiplied by b is the same as b multiplied by a. This fundamental error is very obscure or abstruse, but the effect of this error, I venture to believe, is far-reaching in the highest degree. Indeed, so much so, that I believe the detection of this error will revolutionise our ideas of Ohm's law: $C \times R = E$. This law, I think, will

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be found not true, but the detection of the error will evolve a new law in similar terms to Ohm's law where the fundamental error is eliminated, and this can be experimentally proved. We then know what is electricity. I write very diffidently; I may be in error. I am working out the idea. All I can say is, so far the results are most encouraging.—Yours, etc., FREDERICK HOVENDEN.

Glenlea, Thurlow-park-road, West Dulwich,
March 11, 1895.

UNITED STATES PATENTS.

SIR,—It may interest those of your readers who apply for United States patents to know that on and after April 15 next the time for answering examiner's objections will be six months instead of two years, as has formerly been the case. This change will prevent the repetition of such cases as have been referred to in your journal, whereby patent applications have been kept from issue for many years in order to prolong monopoly. This alteration in the United States rules of practice is the result of the Government suit against the American Bell Telephone Company, which was reported in your columns at the time.—Yours, etc.,

pro J. G. LORRAIN (K. C. E.)

Norfolk House, Norfolk-street, Strand, W.C.,
March 7, 1895.

JERRY WIRING AND UNDERSELLING.

SIR,—Having seen a note in the current number of your paper that Mr. F. G. Baily was going to lecture on "The Scientific Principles of Electrical Engineering," on the invitation of a member of the Northern Society of Electrical Engineers, I thought I would avail myself of the opportunity, but arrived too late. I could not, however, help noticing some remarks made by one or two gentlemen during the discussion.

A question was asked, was there any known means of testing accurately "ampere-meters"? The chairman suggested that some consulting engineer present should answer the question. Whereupon a gentleman, after a pause, got up, and after describing minutely the wonderful instruments at Cambridge—not forgetting to thank the able lecturer, Mr. Baily, for his paper—went on to say that though that was not a place to discuss the lecture commercially, he should like to say one or two things on the commercial aspect of electrical engineering. He began by stating that electrical engineering was like the oil trade—that is, that there is a lot of roguery, or rather robbery, in both—and the only way to save ourselves from it was by educating the people, and consulting engineers on electrical matters. I asked my neighbour who was speaking, as I could not help but think how true his words were, and was told it was Mr. Ferranti.

In my own little experience—take, for instance, ship-work—I have been called a fool for giving all the information I could to engineers on board. Why? Because they get to know too much, and the next time the ship comes in he won't let you put in the time-sheet, "Wire broken, whole circuit gone," when it's only a loose contact in the main switch. That kind of policy is all very well, but I look at this way as the simpler. We can make electrical work the better for trade, and the more we can educate marine engineers and others on electrical work, it is better all round. It prevents disasters at sea, and when employed ashore I would much rather work under the supervision of an engineer who knows something about what you are doing than one who does not. Mr. Ferranti referred at length to the large amount of jerry work carried on.

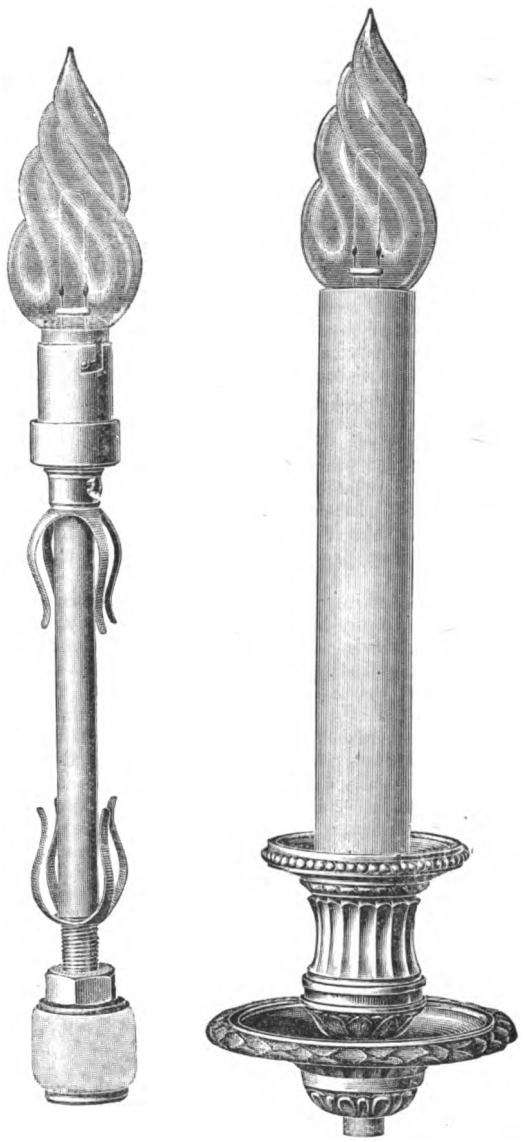
Kindly allow me to speak as a young contractor. I gave an estimate to a gentleman to fit up his shop with six lights at £1 per light, at the same time explaining I was running a risk in doing so. He gave me an order for two arc lights, but the incandescent lights he put over a day or two. Later, he hinted I was charging too much for the incandescent lights, and showed me a tender for the same work, material, etc., at 18s. per light, or, if an inferior class of work was done, 17s. per light. I told him it was impossible. However, he said he did not want to pull me down, and nothing more was done. I mention the latter more because my client was an honest man, but had not the slightest idea of what the electric light was as far as putting in an installation goes, or what it should cost. As for the contractor in question I have nothing to say, only the fact that he put in two prices is sufficient to condemn the principle, if not the man. I would do it properly or not at all, lay down what is a fair price and stick to it—no two prices. I may say the prices for fitting up lights in this neighbourhood vary from 10s. 6d. per light upwards.

In conclusion, I might say that there ought to be a society of electrical engineers throughout the country for the purpose of discussing and developing electrical engineering from a commercial standpoint.—Yours, etc.,

18, Geraint-street, Liverpool, CHARLES RETTIE.
March 11, 1895.

THE "STANDARD" SAFETY CANDLE FITTINGS.

The reduction in the price of incandescent lamps and their immediate accessories during the past year has resulted in more attention being paid to the adaptability of the electric light under circumstances in which its price has hitherto been an obstacle in the way of its adoption. Thus, the imitation candles



which formed an ornamental method of utilising the old-fashioned chandeliers have not been much used owing to their excessive cost, but a new era has commenced. Conical incandescent lamps can now be obtained at a price little, if at all, above that of the ordinary 16-c.p. standard, and as a consequence they are coming more and more into vogue. For this to happen without inconvenient short-circuits, etc., necessitated improvements in the methods of fixing and connecting up, and it is one of these improvements which we now illustrate. This device, which is due to Messrs. Meller and Lowry, is being introduced by Mr. T. G. Poole, of 88, Queen

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Victoria-street, E.C. In the older style of candle fitting, the inner brass tube was supposed to be kept rigid by rubber rings fixed round it, but more often than not they were too small for the opal tube, and consequently had a loose appearance. In addition, the inner brass tube, being small, was used as the return circuit with only one leading-in wire—not at all a safe arrangement. The new arrangement is illustrated. It will be seen that a perfect fit is obtained in any size opal tube by means of the upper and lower metal springs, which can be bent in or out as desired, while the thickness of the rubber ring at the base is also adjustable by means of the small nut above it. The inner tube is of sufficient capacity to admit two leading wires, which can run right up to the holder. This also is small enough to slip into the opal tube, and yet will screw on to the brass tube, and, of course, can be either Edison screw or bayonet joint as required.

ELECTRICAL TRANSMISSION OF POWER IN SHIPYARDS AND ON BOARD MERCHANT STEAMERS.*

BY W. CARLILE WALLACE.

Mr. Thomas Richards, in his presidential address to the North-East Coast Institute, instances as a fact of great importance to large users of power that Messrs. Dorman, Long, and Co., of Middlesbrough, had on some of the outlying originally steam-driven machinery, substituted electric motor driving, the current for these motors being supplied by a 50-h.p. dynamo driven by an ordinary horizontal engine, with the result that a saving of some 30 tons of coal per week was effected, besides dispensing with two Lancashire boilers and the necessary attendance. It at once occurred to the writer that in no class of work more than in shipbuilding would benefit result from electric motor driving, and with this idea in view he at once set himself the task of finding out as far as possible what had been done in this direction, and this paper is to some extent the result of these investigations. After the very clear explanation of the principle of the dynamo and electric motor given by Mr. Mavor in his paper, it is unnecessary to enlarge on this subject. It may be accepted as an indisputed fact that for long distances transmission of power—say, two or three miles—no other system can compete in point of economy with electricity having a high E.M.F.; but in the case before us we have a totally different problem to deal with—namely, the transmission of power for comparatively short distances, say 300 to 400 yards, the current used being of comparatively low tension, probably not exceeding 120 volts, so that the same generating plant can be used for lighting purposes. Further, the loss by leakage through imperfect insulation is very much less than with high-tension currents; naked overhead conductors can be used, and there is no danger to life—in fact, as far as the latter point is concerned, as long as the E.M.F. does not exceed 500 volts, the effect of the current passing through the body would not be fatal.

The condition of things that at present obtains in a shipyard, as is well known to my hearers, is this. There are a number of punching and shearing machines, bending rolls, and machinery of this class placed in light sheds, and for the sake of convenience, partly because the work of these machines is intermittent, and partly because the shed is usually too light to carry shafting, these machines are driven by ordinary high-pressure engines, with cylinders about 8in. or 9in. diameter, and generally devoid of lagging. The steam is supplied from a boiler often a considerable distance from the machines, the steam-pipe in many instances running for some distance in the open air simply covered with non-conducting composition tarred to keep out the damp. Under these circumstances it is needless to say that the condensation is very great. We will take for example the case of a punch. The bulk of the work about a shipyard is, say, $\frac{7}{8}$in. holes in $\frac{3}{4}$in. plate, and the actual power required to do the work at the rate of 30 holes in a minute is about 3 h.p. to 3½ h.p.; but as the machines laid down are usually capable of punching 1in. to 1¼in. holes in 1in plate (besides to provide for shearing, which may be carried on at the same time as punching), the cylinders are much larger than would be required for the average work: the result is that the steam is constantly wire drawn in ordinary work. The following are some tests (see table) carried out on a punching machine in the writer's works. The steam is taken from a boiler at 60lb. pressure, and is carried through a 5in. pipe for a distance of 300ft., where it supplies two machines, and then for a distance of 130ft., where it supplies four other machines; the punch experimented on was one of the two first supplied.

From this table you will see that the indicated power was about double the actual power required to do the work, or, in other words, the efficiency of the machine and engine was 50 per cent. You will notice that the drop in pressure from condensation, etc., was 14lb.; and taking all the facts of the case into consideration, the writer does not think he is overstating the case when he says that when doing average work, the engines driving the punches in shipyards generally are consuming from 80lb. to 100lb. of steam per 1 h.p., or from 160lb. to 200lb. per actual horse-power as required to do the work, and the same will apply to the rolls and every other machine about the yard driven by an independent high-pressure

* Abstract of paper presented to the Institution of Engineers and Shipbuilders in Scotland on January 22.

TRIAL RESULTS OF SHEARING AND PUNCHING MACHINE.—Boiler pressure 60lb.; valve-casing pressure, 46lb.; loss of pressure in pipe, 14lb.; engine cylinder, 9in. by 9in. For diagram, see Fig. 1.

Work done when card taken.	Revolutions.	I.H.P.	Mean press.	Initial press.
			lbs.	lbs.
Running light	51	0·761	5·16	11½
,, ,, ...	84	1·24	5·1	12½
Punching $\frac{7}{8}$in. holes in $\frac{3}{4}$in. plate ...	284	4·64	5·66	20
,, $\frac{7}{8}$in. ,, $\frac{3}{4}$in. ,, ...	200	4·86	8·4	20
,, 1in. ,, $1\frac{1}{4}$in. ,, ...	285	8·15	9·77	27
Shearing $\frac{3}{4}$in. plate	284	4·73	5·77	20
,, $\frac{3}{4}$in. ,, ...	200	4·86	8·4	21
,, $\frac{7}{8}$in. ,, ...	320	8·82	9·54	25

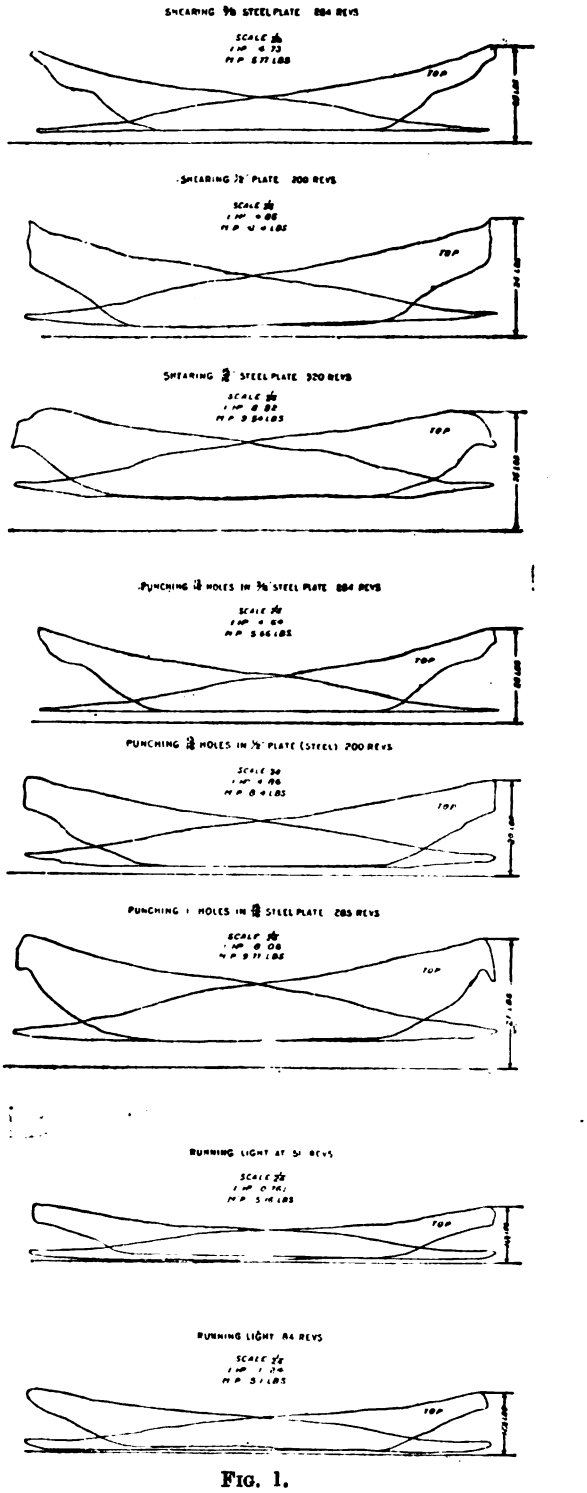
SHEARING ⅝ STEEL PLATE 884 REVS
SHEARING ¾" PLATE 200 REVS
SHEARING ¾" STEEL PLATE 320 REVS
PUNCHING ⅞ HOLES IN ⅝ STEEL PLATE 884 REVS
PUNCHING ¾ HOLES IN ½" PLATE (STEEL) 200 REVS
PUNCHING 1 HOLES IN ¾ STEEL PLATE 285 REVS
RUNNING LIGHT AT 51 REVS
RUNNING LIGHT 84 REVS

FIG. 1.

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engine when the work is irregular. Now, if instead of driving these machines by steam, we substitute electric motors, the current being supplied by a direct-driven dynamo and high-speed triple-expansion condensing engine fitted with some efficient controlling gear, supposing, for the sake of argument, that we require the same equivalent indicated horse-power delivered at the punches that the triple-expansion engine requires 15lb. of steam, and that the efficiency of the dynamo current and motor are collectively 75 per cent. (see table below), we get 15lb. +33 per cent. =20lb. as the amount of steam consumed by the engine to give an equivalent 1 h.p. at the motors.

Distances up to 500 yards should have an efficiency of 75 per cent., the loss of 25 per cent. being made up as follows:

Loss in main generating dynamo	7 per cent.
Loss in mains	3 ,,
Loss in motors	15 ,,

If the motors are all small, say under 8 e.h.p., the loss will be greater.

This alone gives a very fair margin to work on in favour of motor driving, but there is still another advantage to be gained—namely, that the efficiency of the triple-expansion engine is much higher than that of the separate engine on the machine, and that the horse-power given out by the motor much more nearly agrees with the actual power required for the work than is the case when a high-pressure engine is used. Through the courtesy of Mr. Selby-Bigge (who has made a special study of this subject) and Mr. Panton, general manager of Messrs. Dorman, Long, and Co., Middlesbrough, the writer is enabled to give you the results (see table) of the practical application of motor driving in the works of the above-mentioned firm, in which the machinery is of very much the same class as in shipyards. In this case the generating dynamo is driven by an ordinary horizontal engine of a not very economical kind, so that the results obtained speak all the more in favour of motor driving.

TABLE OF ELECTRIC MOTOR TESTS.

Description of machine.	Driven by engine capable of indicating	Replaced by motor capable of indicating	Voltage at generator.	Current taken by motor.	Voltage at motor.	E.H.P. absorbed in doing work.
Group of machines, as under:	Horse-power.	Horse-power.		Amperes.		
Two cold saws..... Two ending machines One sharpening machine	27	10½	120	70	115	10·7
Troughing straightening machine.....	14	3½	120	12	118	1·9
Double-ended punch, punching four holes, one side and one other	14	5	120	25	115	3·7
Straightening machine, all sections	14	3½	120	15	115	2·3
Straightening machine, biggest sections	16	3½	120	35	115	5·4
Cold saw, 26in. diam...	9	3¼	120	15-27	110	2·2-3·9

If we examine this table of motor tests we will see that it bears out to a large extent what the writer has said with regard to the size of the engines fitted to this class of machinery; roughly speaking, the power which the engines in column 1 were capable of indicating was about three times the electrical horse-power absorbed in doing the work, as shown in column 6. Further, from column 6 we are enabled to tell exactly what consumption of steam on the main engine is required to do the work at the motor. Thus the efficiency of a triple engine combined plant—that is to say, the efficiency of the engine and dynamo taken together under full load—would be about 80 per cent.; and if this engine requires about 15lb. of dry steam per indicated horse-power the dry steam consumption per electrical horse-power would be 18·75,* the efficiency of the motor and circuit combined is, say, 75 per cent. (this has been taken low, as the motors are small—see Table IV.), therefore 25lb. of dry steam will give 1 e.h.p. at the motor. The evaporative efficiency of the boiler should be about 7lb. to 8lb. of water per pound of good Scotch coal, and when allowance is made for boiler and steam-pipe losses this should work out about 3·75lb. to 4lb. of coal per electrical horse-power. That the electrical horse-power is much more efficient for driving the machine than an equivalent indicated horse-power in the high-pressure engine cylinder is fully borne out by the results shown in the foregoing table of electric motor tests. It may be as well here to mention that Mr. Panton has informed the writer that so pleased is he with the result of the first installation that he is now putting down a further installation of 200 h.p. There is still a further advantage to be gained by the use of electric motors which it is hardly possible to estimate. The work of the machines in a shipyard is very irregular and intermittent,

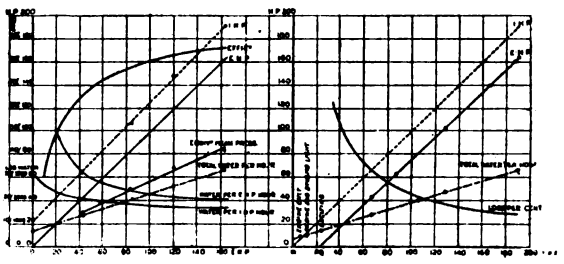

FIG. 2.

the machines sometimes requiring double the power to drive them than at other times, or one machine may be standing for a considerable time while work to a plate is being done in another machine; in the case of a motor the current which it takes is in exact proportion to the work to be done—when it stops the current absolutely ceases and no portion of the power to produce this current is required. It is far different when steam is used, for no matter whether the machines are running half-power or idle, condensation and leakage goes on just the same. Besides, to keep the cylinders clear of water it is necessary to keep the engines running all the time, generally at about 50 revolutions, and if we look back at first table we will see that this is equivalent to about ¾ h.p., which at 80lb. of

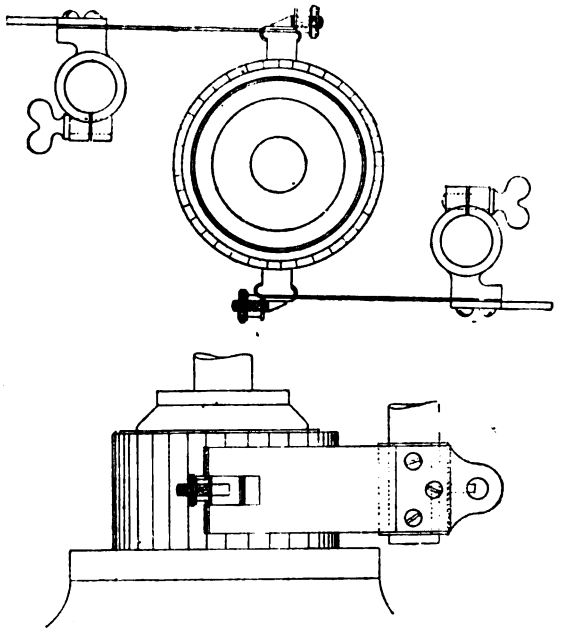

FIG. 3.

steam per indicated horse-power require 60lb. per hour, or as much steam as would be required to drive the machine electrically when punching ⅝in. plates.

TABLE IV.—Efficiency of Motors.

For 3-h.p.	motors	an	efficiency	of	78 per cent.
,, 5-h.p.	,,	,,	,,	80	,,
,, 8-h.p.	,,	,,	,,	84	,,
,, 11-h.p.	,,	,,	,,	86	,,
,, 16-h.p.	,,	,,	,,	87	,,
,, 20-h.p.	,,	,,	,,	87	,,
,, 40-h.p.	,,	,,	,,	89	,,

With regard to the cost of substituting motor driving for the present system, this would vary very much as to circumstances. The simplest way is that adopted by Mr. Panton—namely, removing the connecting rod of the engine and driving by means of a belt from the motor on to the flywheel of the machine (see

* Extract from Prof. Kennedy's report on test of Castle dynamo coupled to Willans's patent central-valve engine: "During the time when the condensed steam was being measured, the mean output was 1,010·5 amperes at 120·2 volts, which amounts to 121·5 kilowatts, or 162·8 e.h.p. The condensed steam amounted to 3,314lb. per hour, which corresponds to 27·3lb. per unit, or 20·3lb. per electrical horse-power hour. The indicated horse-power at the same time works out to 190·2, so that the combined efficiency of engine and dynamo (ratio of electrical output at terminals to indicated horse-power) reaches the very high figure of 85·6 per cent. The steam used per indicated horse-power hour works out to 17·4lb. All these figures represent, as will be seen, the working of the dynamo and engine at a load just below its nominal output, and he further works out the efficiency of the dynamo alone to be 95·6 per cent." (See Figs. 2 and 3.)

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Fig. 4); the conductors will not be an expensive item if carried overhead. As some rough idea of what would be required in this way, a ½in. copper cable will convey about 25 h.p. 300ft. with an E.M.F. of 120 volts and a drop in pressure of about 4 per cent. Suffice it to say in connection with altering existing arrangements, the writer is given to understand that in 12 months the saving in coal, etc., paid for the experimental installation put down at Messrs. Dorman-Long's.

The cost of fitting up a new yard electrically driven should not greatly exceed the cost of the old system. The motors might be fitted on to the machine, cut or helical gearing being used instead of belt driving; the cost of conductors would be much less than that of steam-pipes; much less boiler power would be required; and instead of having separate lighting plant, the same generating plant could be used. It might be considered necessary in large works to divide the generating plant into two units, so that in case of a breakdown the whole work would not be stopped; but the likelihood of such a breakdown is very slight indeed, and as proof of this, a large power installation in Herstal, near Liège, has now been running for three years, and until recently the entire work depended solely on the running of a 500-h.p. dynamo and engine, both for light and power. About 2,000 hands are employed at the works; the large dynamo has never been the cause of cessation from work for a single minute. Once electricity is introduced on a large scale into our shipyards, other uses than those already mentioned will suggest themselves, as boring out stern tubes, hoisting, drilling on board ship, deck planing, etc.

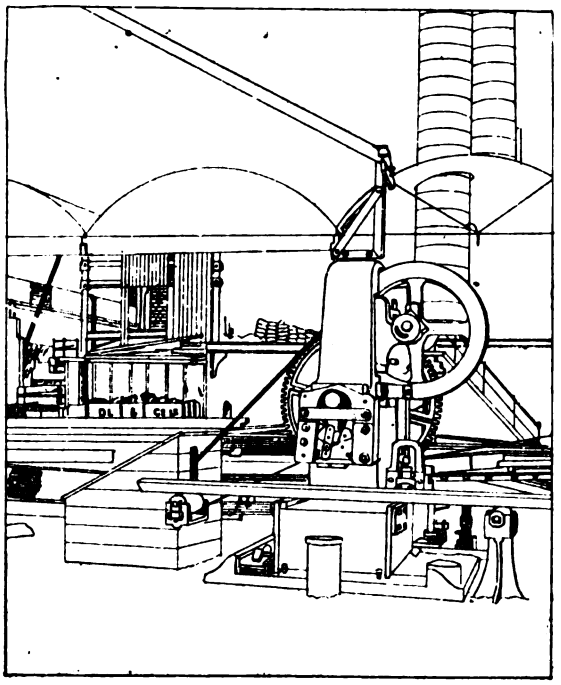

Fig. 4.

As regards wages, oil, etc., this would certainly be less than in the old system, fewer firemen would be required, the motors would require little or no attention, and, with properly arranged lubrication, very little oil indeed.* As to upkeep, of this the writer cannot speak from personal experience, but he understands that the upkeep on an electric power installation already running a number of years, and involving the use of a large number of motors and lamps, can be safely estimated at a little less than 5 per cent. The conductors will give much less trouble than steam-pipes, and there is really nothing about a motor to go wrong except the commutator; but since sparking has been reduced to a minimum, and the introduction of carbon brushes when higher tension currents are used (see Fig. 3), a commutator will run for years without renewal.

The writer might further go on to point out from actual data, that even in workshops and factories electrical transmission of power will compete favourably with shafting and belting, although at first sight this may seem hardly possible, but as this is rather outside the scope of the paper he will content himself with mentioning one or two cases in point. Some little time ago, Messrs. Siemens Bros. and Co. fitted up their works at Woolwich with electrical power transmission, and in the first 12 months they showed a saving of £1,200 over the old system in coal, oil, wages, and upkeep in a 1,000 h.p. installation. Then, if we go the Continent we have the National Arms Factory at Herstal, near Liège; the Royal Arms Factory at Liège; and the zincworks of the Vieille Montagne Company, near Jemeppe, all showing a distinct saving over shaft transmission. The writer thinks he has said enough to prove that electrical transmission of power is now beyond the experimental stage. He is speaking in the interest of economy. We have hitherto been far too lavish in the use of coal in our shipyards and ironworks. The East Coast is waking up to this state of matters, as is proved by what has been done by Messrs. Dorman Long, and Co., and Mr. Selby-Bigge is now busy fitting up the shipyard of Messrs. Furnace, Withy, and Co. with electricity. This yard will be entirely remodelled and driven exclusively by electric motors. He is also advising other shipbuilding firms on the same question. Are we on the Clyde to lag behind in the race? Let us look to our laurels, or, perhaps, when too late we may find we have lost a supremacy we can never regain.

Much that he has said with regard to the extravagant use of steam by punching and shearing machines will apply to the winches, windlass, and capstans on board ship, as also the steering gear, and as all these machines could be quite as well worked by electric motors and at less cost, the writer thinks it is high time the matter received the careful attention of shipowners, shipbuilders, and engineers. Consider the immense advantage it would be to get rid of winch-pipes on deck or along the side, with all the attendant evils of leaking joints, heat, and space taken up, and if they are placed below the deck a leak may damage cargo, or if passing through the passenger accommodation the heat may in the tropics make the rooms unbearable. Then, again, what an advantage in a passenger ship is the absence of noise, as an electrically-driven winch with properly made helical gearing will be noiseless as compared with a steam-driven winch. All our best boats are now fitted with electric light. We have electrically-driven fans for ventilation in many of them fitted by Messrs. Siemens Bros. and Co., and Messrs. Holmes and Co., of Newcastle. It is surely only a little step to enlarge the generating plant, drive it with the most economical class of engine, and work all the auxiliary machinery about the ship by means of motors. The French are now adopting electricity in their men-of-war for training the guns, bringing up ammunition, and all the work usually done by hydraulic power, and if electricity is reliable enough for this class of work surely it is reliable enough for driving winches, etc. Messrs. Siemens Bros. have made electrically-driven winches, and exhibited one at the Naval Exhibition in 1891, but whether any have been actually fitted on board ship the writer is unable to say. As to the cost of electric power installation on board ship, the first cost would probably be more than the present system, but the difference would not be very great, as the less cost of the conductors as against the copper pipes, covering stools, etc., would to some extent meet the extra cost of winches and generating plant, but the difference would be more than made up by the saving in steam and the advantages already pointed out.

* In respect to this, the Electric Construction Company, Wolverhampton, state that the motors in their shop fitted with automatic lubricators run for months without attention.

RAILWAYS IN NEW SOUTH WALES.

The Agent-General for New South Wales has sent us a copy of a supplement to the Railway Commissioners' Annual Reports, giving a short review of the policy adopted by the Commissioners in administering the Government railways and tramways. The Commissioners state that when they assumed office the interlocking of points and signals and the absolute block system of working had not made very great progress, and they determined to move forward with these important questions as quickly as possible. The system of block introduced for the single lines is a combination of the advantages of the "staff" system and the absolute block, known as "Tyer's tablet system" and "Webb and Thompson's electric staff system.' Both systems work excellently; the work and responsibility of the staff have been much reduced, and the traffic greatly facilitated and rendered more secure. For the express trains a system of exchanger has been adopted for the tablet, by means of which the driver can exchange the tablet when running at considerable speed, and the disadvantage of the single lines has been considerably reduced. The same system can be adopted with the electric staff. For outlying country lines a modification of the electric train staff has been arranged, so that if the traffic at any crossing station is too insignificant to justify having a person in charge, the guard of the train can exchange the staff without in any way interfering with the security of working. For working at night with through express trains this system enables staff economies to be effected by permitting of intermediate crossing stations being run through, by giving the driver a through tablet, controlling several sections. This system of working enables intermediate sidings to be opened without the provision of fixed signals, as the most perfect security can be arranged without them.

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PHYSICAL SOCIETY.

A meeting of this society was held on the 8th inst., Mr. Walter Baily (vice-president) in the chair. **Mr. Naber** exhibited, and shortly described, a **New Form of Gas Voltameter.** The chief advantages claimed for this instrument are that either the oxygen or the hydrogen can be collected separately, and that the level of the liquid inside and outside the burette can be made the same, thus no correction has to be applied to the volume of the gas on this account. Variations in the temperature and barometric pressure are allowed for by reading an air thermometer, which is fixed alongside the burette. The inventor considers that this instrument will compare favourably in accuracy with the copper and silver voltameters now in general use Prof. S. P. Thompson considered that now so much care had been bestowed on the design of a gas voltameter, this instrument might issue into more general use than heretofore.

Prof. Minchen gave a short account of a paper by Mr. H N. Allen entitled "**The Energy Movements in the Medium Separating Electrified or Gravitating Particles.**" The object of the paper is to trace out the equi-potential surfaces and lines of flow for two electrified points or gravitating particles, and then to consider the paths along which the "energy cells" move when the charged points or gravitating particles either move towards or away from one another. By energy cell the author understands the small volume of the dielectric bounded by the walls of a tube of force and by two neighbouring equi-potential surfaces, which can be looked upon as containing a certain definite amount of energy. The author gives two figures showing the path of the energy cells (1) when the charged particles come together and meet, (2) when they separate and move off to infinity in oppo site directions. Using Maxwell's expression for the pressure along the lines of force, and the equal tension at right angles required by his theory to account for the attraction exerted by the sun on the earth, the author has calculated the energy density in the medium at the surface of the sun. The value obtained is 16 horse-power hours per energy cell. Hence, he concludes that at a distance from all gravitating bodies, an energy cell of ether contains at least this amount of energy. Prof. Minchin showed how by the use of polar co-ordinates the expressions given by the author could be simplified. He also gave a graphical method of obtaining the equi-potential surfaces for any configuration having given those for any other configuration. He pointed out that by a similar line of reasoning to that used by the author the energy per energy cell of the medium at the surface of Arcturus must be 8,100 times as great as at the surface of the sun, so that the minor limit given above by the author must be multiplied by 8,100 at least.

BRIGHTON CORPORATION ELECTRIC LIGHTING ACCOUNTS.

The accounts of the electric lighting department of the Brighton Corporation for the year ended December 31, 1894, have been issued. The expenditure during the year amounted to £40,840, and the total expenditure to December, 1894, has reached the sum of £119,382. We give below the revenue account and general balance-sheet.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1894.

Dr.	£ s. d.	£ s. d.
A.—To Generation of Electricity.		
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£2,016 4 5	
Oil, waste, water, and engine-room stores	558 17 0	
Wages at generating station	954 5 3	
Repairs and maintenance—buildings, £165. 2s. 11d.; engines, boilers, dynamos, exciters, transformers, motors, etc., other machinery, instruments, and tools, accumulators, and accessories, £426. 11s. 4d.	591 14 3	
		4,121 0 11
B.—To Distribution of Electricity.		
Wages and other remuneration to linesmen, fitters, and labourers, repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	79 9 6	
Repairs, maintenance and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of materials and lamps, sold, as *per contra*	605 3 6	
		684 13 0
C.—To Public Lamps.		
Attending and repairs, including materials supplied		419 8 5
E.—To Rents, Rates, and Taxes.		
Rates and taxes		86 12 7
F.—To Management Expenses.		
Salaries—viz., engineer's department, accountant and clerical staff	758 7 1	
Stationery and printing	119 19 10	
Registrar of stock and stamp duty	75 16 1	
General establishment charges	146 17 2	
		1,101 0 2
H.—To Special Charges.		
Insurances	72 12 9	
Law expenses, £9. 2s. 10d; less costs recovered, £4. 4s.	4 18 10	
		77 11 7
Total expenditure		6,490 6 8
Amount carried to net revenue account		9,800 0 0
Balance to be carried to next account to provide for bad debts		89 9 0
		£16,379 15 8

Cr.	£ s. d.	£ s. d.
A.—By Balance.		
Balance from last account	158 4 4	
Less bad debts written off	153 3 0	
		5 1 4
B.—By Electricity Sales.		
Sale of current per meter—		
422,077 units at 7d	12,310 11 7	
109,989 ,, at 3½d.	1,604 0 1	
	13,914 11 8	
Less allowances	1 13 6	
		13,912 8 2
C.—By Public Lamps.		
Public lighting—		
14,600 units at 7d.	425 16 8	
37,035 ,, at 3½d.	540 1 10	
Attending etc.	419 8 5	
		1,385 6 11
D.—By Meter Rents and Sundries.		
Rental of meters and other apparatus on consumers' premises	614 4 10	
Work executed on account of customers	398 15 8	
Rents receivable	63 7 9	
Fees for accounts sold	1 0	
		1,076 9 3
Carried forward		£16,379 15 8

Dr. NET REVENUE ACCOUNT.	£ s. d.
Interest on redeemable stock debt paid to loans fund and accrued due to date	2,663 2 11
Sinking fund appropriations transferred to loans fund and accrued due to date	2,351 7 10
	5,014 10 9
Balance to be carried to next account	5,085 9 3
	£10,100 0 0

Cr.	£ s. d.
Balance from last account	300 0 0
Balance brought from revenue account	9,800 0 0
	£10,100 0 0

GENERAL BALANCE-SHEET.

Liabilities.	£ s. d.	£ s. d.
Capital—amount received		120,531 0 0
Less premiums, etc., on stock issued		12,450 12 9
Total stock issued		108,080 7 3
Less amount appropriated for extinction of stock and accumulations of interest thereon		5,182 18 0
		102,897 9 3
Premiums on stock issued	£13,118 3 1	
Less costs and expenses of issuing stock	667 10 4	
		12,450 12 9
Sundry creditors		12,183 3 1
Customers' deposits		265 0 0
Interest accrued due		631 0 0
Proportion of appropriation in respect of sinking funds accrued due		1,557 0 0
Revenue account—balance at credit thereof		89 9 0
Net revenue account—balance at credit thereof		5,085 9 3
To excess of assets—viz.:		135,159 3 4
Amounts provided for extinction of stock to December 31, 1893	3,247 9 3	
Ditto this year	2,351 7 10	
Accumulations by investment	213 13 5	
	5,812 10 6	
Less premiums and costs of stock purchased for extinction	629 12 6	
		5,182 18 0
		£140,342 1 4

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Assets.	£	s.	d.
Capital account—amount expended for works	119,382	0	10
Stores on hand at December 31, 1894: coal, £175. 6s. 3d.; oil, waste, etc., £96. 10s.	271	16	3
Sundry debtors for current supplied to December 31, 1894	7,178	4	9
Other debtors.....	10	0	0
Cash on deposit £28,029 11 3			
Ditto in manager's hands..... 20 0 0			
28,049 11 3			
Less due to treasurer 14,549 11 9			
	13,499	19	6
	£140,342	1	4

LEGAL INTELLIGENCE.

ATTORNEY-GENERAL v. ST. JAMES'S AND PALL-MALL ELECTRIC LIGHTING COMPANY.

In this case, which was decided on Tuesday before Mr. Justice Kekewich in the Chancery Division of the High Court of Justice, the Attorney-General, at the relation of the Vestry of St. James, Westminster, sought for an injunction to restrain an alleged public nuisance by vibration, noise, emission of gas, smoke, effluvia, steam, and hot water, caused by the works of the defendants, at their central station, in or near Mason's-yard and Duke-street, Piccadilly. The proceedings on the part of the Vestry were instituted under the provisions and powers of the Public Health (London) Act, 1891 (54 and 55 Vict., c. 76), Sections 13 and 21). One of the defences raised on the part of the defendants was that the acts complained of were justified by the terms of the provisional order by which they were regulated; but it was now conceded that, having regard to the decision of this Court (affirmed by the Court of Appeal) in the case of Shelfer *v.* the City of London Electric Lighting Company, and which it is believed will be the subject of consideration by the House of Lords, that defence could not avail. The case accordingly turned on the question of fact whether or not the acts of the defendants constituted a nuisance.

Mr. Warmington, Q.C., and Mr. Macmorran appeared for the plaintiffs; and Sir Richard Webster, Q.C., Mr. Fletcher Moulton, Q.C., and Lord Robert Cecil for the defendants.

Mr. Warmington had stated the case, and was proceeding to call the first out of numerous witnesses, when

Sir Richard Webster interposed, and terms of settlement were agreed upon similar to those which it was stated had been arranged in an action before Mr. Justice North, brought by the Windham Club against the present defendants.

Mr. Justice Kekewich by consent made an order that if, in the opinion of an engineer to be appointed by the Board of Trade or by agreement between the parties, the works of the defendants in Mason's-yard now caused, or hereafter should cause, any nuisance by vibration or noise, or by permitting to escape from the chimney shaft of the works black smoke, soot, ashes, or dust, or effluvia offensive and injurious to health, or by the discharging into the sewers of the Vestry of hot water or steam, the defendants would forthwith at their own expense make and execute all such works necessary for remedying the nuisance as the engineer should direct. The defendants were to pay the costs of the action and the expenses of the engineer, the costs of the enquiry before the engineer to be at his discretion.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY v. BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

This action, which was heard before Mr. Justice Romer, was to restrain the defendants from reducing the telegraphic rates which had been fixed by what was called the "joint purse agreement." Under a subsequent arrangement the defendants had agreed to pay the plaintiffs £6,000 a year on the defendants extending their system. The defendants contended that under the altered arrangement the terms of the original agreement were varied so as to enable them to make a reduction in rates without special agreement with the plaintiffs or under arbitration, as provided by the original agreement.

Mr. Justice Romer held that there was no power to reduce the rates, and made a declaration to that effect, and he obtained from the defendants an undertaking not to reduce the rates except according to the original agreement.

SOUTH v. HARRIS.

In the Westminster County Court on Thursday of last week the case of South *v.* Harris was tried before his Honour Judge Lumley Smith, Q.C. It was an action by the plaintiffs, a firm of electrical engineers, to recover a balance of account in respect of electric light work carried out to the order of the defendant, who carries on business as a jeweller at Cranbourne-street, Leicester-square.

It appeared that a written contract was entered into between the parties by which the plaintiffs were to fit up the electric light throughout the defendant's premises for an agreed sum, and so far as the contract was concerned there was no dispute, but the plaintiffs now claimed for three extra lamps, which were fitted up to the order of the defendant, and were quite outside the contract.

The **Defendant** was called, and said he did not dispute that the work was done, but he contended that the price which was charged for it was excessive, and that 15s., which sum he had paid into court, was quite sufficient.

After hearing the evidence of the witnesses, his **Honour** said he was satisfied that the plaintiffs' claim was a reasonable one, and he therefore gave judgment for the full amount claimed, with costs.

COMPANIES' MEETINGS AND REPORTS.

HOVE ELECTRIC LIGHT COMPANY, LIMITED.

The third annual general meeting was held on Tuesday at the Cannon-street Hotel, E.C., Colonel H. Wood presiding.

The **Chairman**, in moving the adoption of the report and accounts (which were given in our last issue), stated that the progress of the Company continued in every way satisfactory. The sale of current to consumers had increased from £1,265 last year to £3,508, and the result of the past year's working had been a profit of £1,243, as against £77 for the previous 12 months. After deducting £563 for interest accrued on loans and debentures, there was a net balance to the credit of revenue account of £679. The directors proposed to write off £73 from the suspense account, and to declare a dividend for the year of 3 per cent. During the current year their customers had considerably increased, and it was evident that the profits would be larger than in 1894.

The motion was seconded and carried.

BIRMINGHAM ELECTRIC SUPPLY COMPANY, LIMITED.

The annual meeting was held last week at the offices of the Company, 14, Dale-end, Birmingham, Mr. Henry Buckley (chairman) presiding.

The **Chairman**, in moving the adoption of the report (which was given in our issue of the 1st inst.), said he was glad to tell them that during the past year there had been an increase of about 20 per cent. in the output of current, but he was still better pleased to say they had an increase in the number of consumers of something like 28 per cent. It was true that their average price per unit was not so large as last year, but that was partly due to the fact that motors were now beginning to be used, and the directors hoped that each year would see a considerable increase in that direction. Indeed, he was satisfied that would be so, especially when they were able to supply the jewellers' quarter, for where only ¼ h.p. or ½ h.p. was needed it was impossible to get anything more convenient or economical than motors. It would be seen from the accounts that they had amply earned, and more than earned, the dividend recommended in the report (4 per cent.). As to their proposal to carry forward £1,001 to next year's account, they felt that such a course would add materially to the stability of the Company, and they would, moreover, be undertaking a considerable capital expenditure in the ensuing year which to some extent would be unremunerative. They did not want to pay a decreased dividend next year, and he was satisfied that under the arrangement proposed they would be able to maintain the same dividend, or possibly to declare an increased one. The directors had quite made up their minds to reduce the price to consumers almost immediately, being of opinion that the increased demand which would result would more than make good the diminution of profit per unit. Since the directors last met the shareholders they had obtained from Parliament powers to enter the jewellers' quarter and an area at Edgbaston. They had therefore acquired the sites necessary for laying down distributing centres in Newhall-street and near the Ivy Bush, Edgbaston, but they would have sufficient room at the existing generating station to supply the demand during the next three or four years. It would be necessary for them shortly to call up the unpaid capital of £2 on their 10,000 shares; and in order to further strengthen the position of the Company, and to deal with the extension of business when the necessity arose, the directors recommended that the capital of the Company be increased from £100,000 to £200,000. In concluding, the Chairman said that in the opinion of the directors the concern was never in a sounder or more promising condition than it was at present.

Mr. Arthur Kean, in seconding, spoke in high terms of the manner in which the affairs of the Company had been conducted, but took exception to a proposal contained in the report that the new shares should be issued "at such times and on such terms as the directors may from time to time think fit." It appeared to him, he said, that the present shareholders should have an opportunity of taking those shares *pro rata* when they were allotted.

The **Chairman**, replying to a question as to the extent of the reduction in price proposed to be made, said the price charged now was subject to a sliding scale according to the amount of consumption, varying from 8d. to 6d., and the proposal was, though no resolution had been adopted, to reduce the scale to 7d. and 5d. With regard to the new capital they desired to raise, the idea of the directors was not to attempt to issue the whole of the shares at once, but to issue them in blocks, offering them first of all to existing shareholders. He should like to see them issued at a premium, to be applied in wiping out their preliminary expenses.

The motion was then put to the meeting, and the report was adopted.

The **Chairman** next moved: "That the capital of the Company be increased by £100,000, divided into 20,000 shares of £5 each

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(making the total nominal capital £200,000), to be issued at such times and on such terms as the directors may from time to time think fit." This motion was, with slight modification, also passed.

Messrs. G. S. Albright and G. H. Johnstone were re-elected directors, and Messrs. Sharp, Parsons, and Co. auditors. The meeting closed with a vote of thanks to the chairman and Board of Directors.

IMPERIAL TRAMWAYS COMPANY, LIMITED.

The following is an abstract of the report for 1894 of the directors (Mr. George White, Bristol, chairman; Mr. Hugh C. Godfray, London; and Mr. J. Clifton Robinson, A.I.C.E., London, managing director) to be submitted at the thirty-second ordinary general meeting to be held at the Company's Offices, Clare-street House, Bristol, on the 16th inst., at 2 p.m.

Dublin Southern District Tramways Company.—The gross receipts of this Company are almost identical with the figures of the comparative period of 1893, though there has been a substantial saving in the expense for forage and the total expenditure being about £126 less, the net profit allows of a dividend on the £70,000 share capital at the rate of 2½ per cent., as against 2⅛ per cent. in the previous year. Since the last general meeting the Board have been constantly engaged in the negotiations relating to this undertaking, and have now the satisfaction of reporting the conclusion of a definite contract with the British Thomson-Houston Limited The works will include the reconstruction of nearly the whole length of tramways as double lines, in lieu of the existing single line with passing places, as well as the complete electrical equipment, including building alterations, generating and distributing plant, and motor cars. The scope of the contract has been extended to include the section from Kingstown to Dalkey (about two miles), at present a single line of 4ft. gauge, which will be relaid as double lines of the 5ft. 3in. gauge and equipped for electrical working uniformly as part of the through line from Dublin to Blackrock and Kingstown. The contract price is £109,200, to be satisfied by the payment of £10,000 cash and the issue of £30,000 5 per cent. debentures and £69,200 5 per cent. preference shares, both of the Dublin Southern Company. The operations have already been commenced, and it is anticipated will be completed in about four months.

Middlesbrough Tramways.—The tramway returns of this undertaking show a satisfactory increase of £226, though the boat receipts are not so favourable, and the expense of working the steamers includes some exceptional repairs. The net result is a profit of £363, equivalent to about 4½ per cent. per annum on the Imperial Company's capital involved.

Reading Tramways Company, Limited.—The gross receipts of this company are £133 higher, and the working expenses £63 more than for the corresponding half-year. The net increase enables the same rate of dividend—viz., 7½ per cent. per annum—to be maintained on the somewhat larger capital of £23,250.

General.—The net profits from all sources for the half-year amount to £2,687. 0s. 10d., as compared with £2,438. 5s. 4d. Adding the balance brought forward, the amount available is £2,818. 17s. 6d. Interest on debentures has already absorbed £449. 9s. 3d., and the directors have pleasure in recommending that the balance be appropriated as follows—viz., in payment of dividend on the preference shares at 6 per cent. per annum, £349. 16s.; dividend on the ordinary shares at the rate of 1½ per cent. per annum, £799. 13s.; addition to reserve funds for renewals and contingencies, £500; and carry forward to the credit of the succeeding account, £719. 19s. 3d. The Board consider it desirable to carry forward a larger unappropriated balance than usual, in view of the fact that the extensive interference with the Dublin Company's traffic will temporarily affect the revenue from that source. The directors retiring by rotation at the ensuing meeting are Messrs. Hugh C. Godfray and J. Clifton Robinson, and, being eligible, they offer themselves for re-election. The auditors, Messrs. James Fraser and Sons, also retire and are eligible for re-election. It is proposed to make the dividends payable on the 19th inst.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Eccles (Lancs.).—The Corporation desire by to-morrow tenders for an electric light installation at the sewage farm works, Peel Green-road, Patricroft.

Norwich.—The Town Council require by April 2 tenders for the supply of two Galloway boilers and the installation of electric light fittings at the new baths.

Manchester.—The Manchester, Sheffield, and Lincolnshire Railway Company require tenders by the 19th inst. for the supply, among other stores, of telegraph materials, tools, and oil.

India.—The Great India Peninsula Railway Company, with offices at 48, Copthall-avenue, E.C, invite tenders by the 21st inst. for the supply, among others, of galvanised iron tubes and miscellaneous wire.

Stowmarket.—The Urban District Council require by April 15 tenders for lighting the streets of Stowmarket from August 15 next to May 15, 1896, and also for lighting the post office clock. Particulars may be had of Mr. S. Prentice, clerk.

Bradford.—The Corporation require tenders by the 28th inst. for the construction and delivery of two steam dynamos. Specification may be had on application to Mr. Baynes, Electricity Department, Town Hall, Bradford, on payment of £1. 1s.

Derby.—The Corporation require by the 18th inst. tenders for the construction of three mild-steel Lancashire boilers and their accessories. Plans may be seen, and specification obtained, of Messrs. Bramwell and Harris, 5, Great George-street, Westminster, S.W., or of the town clerk, Derby, on deposit of £2. 2s.

Nottingham.—The Corporation invite by the 28th inst. tenders for two Lancashire steel boilers (26ft. long and 7ft. diameter) and fittings, and placing same on their seats at the public baths, Sneinton. Plans may be seen and copies of the specification obtained at the office of Mr. Arthur Brown, M.I.C.E., borough engineer, on payment of £2 2s.

Llanelly.—The Borough District Council desire by the 25th inst. plans, designs, specifications, and estimates of cost for the supply and installation of electrical plant and machinery, including street lamps and laying down mains. Plans of the district can be obtained from Mr. George Watkeys, C.E, borough surveyor, Llanelly. The plans, etc., are to be sent to the clerk of the Council before the 25th inst.

Worcester.—As will be seen from our advertisement columns, tenders are invited by the 6th of April for wiring the Victoria Institute. Copies of the specification may be obtained from the architects, Messrs. Simpson and Milner-Allen, 10, New-inn, Strand, London, W.C., accompanied by a deposit of £1. 1s. Plans of the lighting system may be seen at their offices, and on the works. Tenders are to be delivered at the offices of the architects.

Madrid.—The Electricity Supply Company for Spain, Limited, invite tenders for the supply and erection of certain machinery, etc., for the extension of their electricity works in Madrid. The plan of buildings and statement of requirements, with terms and conditions of tender, may be obtained at the office of the company, 15, St. Helen's-place, London, E.C., or of Mr. Robert Hammond, the consulting engineer, Ormonde House, Great Trinity-lane, London, E.C., on payment of £1 1s. Tenders must be addressed to Mr. P. A. Latham, secretary, by the 27th inst.

RESULTS OF TENDERS.

Ayr.—The Town Council have accepted the following tenders for the erection of the electric light station: mason work, Mr. Robert Hutchison, £3,303; slater and plumber work, W. Highet and Son, £356; carpenter, joiner, and painter work, D. and J. Milligan, £1,147; being a total of £4,806.

BUSINESS NOTES.

Ayr.—The Town Council have accepted tenders for the erection of the electric light station.

Western and Brazilian Telegraph Company.—The receipts for the past week were £3,639.

Wimbledon.—The Urban District Council have under consideration a scheme for lighting the town.

Portsmouth.—The Town Council decided last week to put down at the public baths an electric motor and centrifugal pump.

Tilbury.—The Parish Council have appointed a committee to consider the question of lighting the district by gas, electricity, or oil.

Salisbury.—The Town Council last week decided to discuss in committee the order obtained by the Salisbury Electric Lighting Company.

Hobart Tramways.—A meeting of the Hobart Electric Tramway Company was held on Wednesday at the offices, College-hill-chambers, E.C.

Chiswick.—The Works Committee reported to the District Council last week that the work at the electric light station was now proceeding satisfactorily.

Rothesay.—The Harbour Trust and Town Council on Tuesday met the Provost and Mr. Mavor, of Messrs. Mavor and Coulson, electrical engineers, with reference to the proposed electric lighting of the harbour.

Poplar, E.—The Poplar District Board of Works resolved last week that it was inexpedient for the Board to take any action on the subject of loans from the London County Council for electric lighting purposes.

Wells.—The Town Council have decided that the town shall be lighted by electricity. A concession for this purpose has been granted to Mr. D. Brown, and he has been given the public lighting at £350 per year.

Hammersmith, W.—The Vestry have decided to at once carry into effect the provisions of their electric lighting order by contract or direct The Electricity Committee are now considering carefully the latter part of the question.

Leith.—The arc lamp installation at Leith Docks and Harbour is rapidly approaching completion, and one of Heathman's extension ladders, mounted upon a spring carriage with 3ft. 6in. wheels, has been ordered for use of the lamp trimmers.

Debenture Issue.—The Chelsea Electricity Suppy Company, Limited, have this week offered for subscription £60,000 4½ per cent. debenture stock at £103. The stock will, after December 31, 1910, be redeemable on six months' notice at £110.

Eccles.—The Eccles Corporation have appointed Mr. Clirehugh, of Temple-chambers, Brazennose-street, Manchester, their consulting engineer for carrying out an electric lighting scheme. It is understood that an expenditure of about £20,000 is contemplated.

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Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 10th inst. amounted to £937, as compared with £687 in the corresponding week of last year.

Stair Treads and Manhole Covers.—The Safety Tread Syndicate, Limited, of 15, Barbican, E.C., and 101, Bothwell-street, Glasgow, have sent us a copy of their new catalogue of non-slipping stair treads, hydrant and manhole covers, coal-plates, etc.

Wigan.—The Gas Committee have referred back to the Electric Lighting Sub-Committee the question of deciding whether they think it necessary to engage a specialist on electric lighting to advise them on the schemes and tenders received by the Corporation.

Pipe Contract.—Messrs. Edward Le Bas and Co., of 49, Lime-street, E.C., inform us that they have just secured the contract for the whole of the lap-welded wrought-iron pipes required by the City of London Electric Lighting Company for their cable conduits, the delivery to extend over a certain time.

Partnership.—Messrs. Woodthorpe, Bevan, and Co., of Leadenhall-buildings, E.C., have particulars of a scheme in connection with which two gentlemen, who are engaged in enlarging an existing electric power station in America, are desirous of finding two or three others to join them in the enterprise.

City and South London Railway.—The receipts of the Company for the week ended March 10 were £971, against £930 for the corresponding week of 1894, or an increase of £41. The total receipts for the current period of the present half-year are £9,911, against £9,474 in the corresponding period of 1894, an increase of £437.

Perth.—It is stated that an action has been raised in Perth Sheriff Court by W. A. Bryson, electrical engineer, Glasgow, against the Magistrates and Commissioners of Crieff, and Provost Adie, as an individual, for £26. 5s., being fee and expenses for providing a report upon the Falls of Barvick water supply for the purpose of electric lighting in Crieff.

Acton.—The District Council last week considered a letter from Messrs. New and Mayne with reference to the electric lighting agreement, stating that they would be prepared to substitute 16-c.p. lamps instead of 10-c.p. lamps for general street-lighting, and in the main road to put in arc lamps similar to those at Ealing. It was decided to discuss the matter in committee.

Briton Ferry.—On Saturday at the Villiers Tinplate Works, Briton Ferry, the electric light plant was set in operation. Invitations were sent out by the engineer and contractor, Mr. Herbert Lewis. The engine was made by Messrs. Taylor, Struve, Eton, and Price, the dynamo by the Electric Construction Company, and the fittings by the Edison and Swan Company.

Birmingham.—The committee of the municipal technical school met on Monday, and decided to report to the Council that, having carefully reconsidered the matter of the tenders for the electric lighting plant at the new building in Suffolk-street, they can only repeat their original recommendation—namely, that the tender of Messrs. D. and G. Graham, of Glasgow, be accepted.

Llanrwst.—The Guardians had under consideration last week a letter from Messrs. Gower and Jones, Trefriw, asking whether the Guardians would exchange with them a piece of land running alongside the workhouse for another piece of land. The land was required for the purpose of laying down an electric tramway from Trefriw to Llanrwst Station. The consideration of the matter was deferred.

Sunderland.—The lighting of this town by electricity was formally inaugurated at the Town Hall on Wednesday of last week, when the Mayor turned on the current to the two arc lamps outside the Town Hall. The Town Hall is illuminated by 103 lamps of 8 c.p., 112 of 16 c.p, 68 of 32 c.p., and one of 300 c.p. The Doulton conduit has been used throughout for the accommodation of the mains.

Private Lighting.—Mr. Whiteley's establishment at Westbourne-grove and Queen's-road is having an extension of the electric lighting. Arc lamps are being fixed outside each of the shops, and a Heathman's telescopic tower ladder has been procured for attending to the lamps. Messrs. Jones and Higgins, the drapers at Peckham, have also purchased Heathman's tower ladder for arc lamp attendants.

Alderley.—Dr. Burgbardt, in moving at the last meeting of the Urban District Council the rescinding of the resolutions having reference to the electric lighting provisional order, criticised the action of the Council, and said he did not want the ratepayers to think they had finished paying as they had not been taken into confidence. He protested against the expenditure. Mr. Church seconded the motion, but it was lost on a vote.

Walsall.—The Town Council on Monday adopted a recommendation of the General Purposes Committee, that a resident electrical engineer, at a salary of £150 per annum, should be appointed to take charge of the electric lighting works. The Council also decided to acquire three transformer stations, and to make certain contracts, so that the Corporation may be in a position to supply the light in the coming autumn.

Lambeth, S.E.—The Lambeth Vestry last week received a letter from Mr. S. Morse stating that if the Vestry would appoint a committee he would be pleased to submit a proposal to them on behalf of the County of London and Brush Provincial Electric Lighting Company, Limited, for the transfer to the company of the Lambeth electric lighting order. The Vestry resolved to ask Mr. Morse to submit his proposals direct to the Vestry.

New Lead Accumulator.—Mr. Arthur Duffek, director der ersten Prager Elektrotechnischen Commandit Gesellschaft, 6, Ferdinand-strasse, Prague, announces that he has succeeded in constructing a new lead accumulator which surpasses all existing systems. The invention is patented in all civilised countries, and the foreign rights, as well as those for Austria-Hungary, are for sale. Persons interested are requested to address the owner of the patent, as above.

Brechin.—The clerk intimated to the Burgh Commissioners on Monday, that he had received a letter from the agent of the House-to-House Electric Supply Committee stating that their application for an order empowering that company to supply electricity to Brechin would be refused unless certain conditions in the agreement, to which the Board of Trade objected, were withdrawn. The Commissioners agreed to consider the subject in committee.

Worcester.—We are glad to observe that Mr. T. Caink, the city engineer, has issued a statement in self-defence in regard to the extras incurred in connection with the municipal electric light station, and for which he disclaims the responsibility sought to be put upon him by the Electricity Committee. The Board of Guardians last week adopted the report of the Building Committee in regard to the wiring of the male block and workshops now in course of erection.

Fermoy.—The Clerk mentioned to the Town Commissioners last week that Mr. C. J. Furlong, J.P., had informed him that a firm of electricians was prepared to erect the necessary plant to light Fermoy with the electric light provided it would be guaranteed that ultimately there would be a probability of 2,000 lights. The Chairman said he thought that if the scheme would pay a firm like that it should pay the Commissioners, and he would be in favour of their keeping it in their own hands.

Adjustable Swivel Bearings.—A card has been issued by the Unbreakable Pulley and Mill Gearing Company, Limited, of London and Manchester, illustrating their adjustable swivel bearings. It is claimed that by the adoption of this type of bearing a considerable saving in the power transmitted is effected as compared with the ordinary rigid bearing with brass steps, that the bearings run for years without attention, and that the long surface allows of the oil film to be maintained.

Blackpool.—The street electric lighting system is to be extended by the addition of three lamps in Church-street, three lamps in Talbot-road, and six lamps in Claremont-park. The minutes of the Electric Lighting and Tramways Committee, presented to the Town Council last week, mentioned that the tender of Messrs. Crompton and Co. had been accepted for two dynamos and one spare armature for the tramways department. Mr. R. Hammond's report on the motor commutator supplied to the electricity works was read at the same meeting.

Sheffield.—Sir Frederick Mappin, chairman of the Sheffield Gas Company, mentioned at a meeting of the company on Tuesday that the manager of the Sheffield Electric Light Company had written that if it is true that the Welsbach burners reduce the income of gas companies 50 per cent., it is difficult to understand the eagerness of gas companies to fix them. But surely, the chairman said, if they could give an article worth double the money it was their duty, and also their interest, to supply it, and they had pretty well found that to be so.

Electric Power in Mining Operations.—The statutory meeting of the United Pioneer Gold Mining Company, Limited, was held on Monday at Winchester House, Old Broad-street, E.C., under the presidency of Colonel Josiah Harris, who stated that the water difficulty had now been got rid of, as their crushing mills would be worked by electricity, the power for which would be supplied by the Moodies Exploration Company. Pending the erection of the necessary plant, they had been informed by their manager that they had sufficient water to supply a 15-stamp mill until the end of June.

Accrington.—The Legal and Parliamentary Committee of the Town Council have had under consideration the information received from other boroughs as to electric lighting stations, and the desirability of proceeding with or postponing the establishing of a station for the borough. It was resolved that the further consideration of the subject be postponed until the committee have received from the Manchester Steam Users' Association a special report on a new boiler being erected at Keighley on the "Livet" principle, whereby ashpit refuse can be used for the production of steam power.

Incandescent Lamps.—Mr. G. Straus, of 130, Queen Victoria-street, informs us that the fact of his having lately relinquished one of his agencies for incandescent lamps does not in any way interfere with his business. He continues to supply lamps as hitherto, and he has made arrangements to have a much larger and better assorted stock on hand for immediate delivery. Mr. Straus's works will, as heretofore, take care that no lamp is sent out without being tested, but as an additional guarantee to supply none but perfect lamps, he has arranged to have every lamp retested before leaving his warehouse.

Edinburgh.—The Town Council last week adopted a motion in view of the introduction of the electric light into the city, remitting to the Lord Provost's Committee to consider and report whether, and if so what, steps should be taken in the interests of public safety to secure that any faults in the gas-mains and service pipes shall be detected and removed without delay, and to provide against any dangers likely to result from insufficient piping. The Electric Lighting Committee of the Town Council on Tuesday provisionally fixed Wednesday, April 10, as the day for turning on the electric light in the city.

Bowness.—The chairman of the Urban District Council read a letter last week to the Council from Mr. D. Cloudsdale, asking

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that more lamps should be put in on the road which had been constructed by himself and Mrs. Pritt and handed over to the Council. The Chairman said that then was the time for the Council to determine where new lamps, if any, were required. Once the bargain was made with the electrical company no extra lamps could be added. Every new street that was made was thrown upon the public to keep up, so the Council would be in order whether they put in or took up lamps.

St. Luke's, E C.—The Works Committee reported to St. Luke's Vestry last week that the clerk had submitted a letter from the engineer of the County of London and Brush Provincial Electric Company, Limited, of the intention of the company to commence the supply of electricity in the following thoroughfares: Finsbury-pavement, Cross-street, South-street, South-place, Finsbury-square, Worship-street, and Wilson-street. The Vestry decided to send to the Board of Trade a letter enclosing the resolution passed at a former meeting of the Vestry in opposition to the construction of transformer-chambers in the main thoroughfares of the Metropolis.

Sale of Plant.—The St. James's and Pall Mall Electric Light Company, Limited, announce that in consequence of the extension of supply from their central electric lighting stations necessitating the use of larger units of plant, the following machinery is for disposal by private tender: four sets of Willans i.h.p. and two sets of Willans "G, G." 80-i h.p. engines, coupled to dynamos by Messrs. Siemens Bros, and Messrs. Latimer Clark, Muirhead, and Co., suitable for modern electric supply on the low-pressure system. Communications should be addressed to the general manager and secretary, at the company's offices, Carnaby-street, Golden-square, London, W.

Nottingham.—On Friday night the effect of the complete installation of electric light in the Market place was witnessed for the first time. Since November four lamps, each of 2,000 c.p., have stood there Changes in the positions of the four have been made as the result of experience, and they now stand so that all the street approaches to the Market-place are illuminated to the best advantage. The additional four, which are of similar intensity, have been placed at the north and south sides, two lighting the Long-row and two the South-parade. Alderman Ford, the chairman of the Lighting Committee of the Town Council, switched the lamps on at seven o'clock. The Church of St. Thomas is now lighted by electricity.

Pemberton.—A deputation, consisting of Messrs. Gaskell and Sharrock, attended before the District Council last week to apply for the permission of the local authority to cross the highway by wires at any point deemed necessary, and to erect the poles on the highway for the purpose of carrying the aforesaid wires, and to put plant down in West Ward with the view of supplying the electric light. The deputation pointed out that it was proposed to put down plant to energise 300 16-c p. lamps. A plan was produced showing where the generating plant was to be located, and the direction in which the wires would be placed. The Council decided that the subject be considered at a further meeting.

Rye (Sussex).—The Rye Trade Association on Tuesday discussed the question of the Rye and Camber tramway. Councillor Hayles (the chairman of the company) stated that the company were about to close with a party as to the tender for constructing a permanent way. The cost would be about £1,200. The company were also in treaty as to whether the tramway should be worked by steam, oil, or electricity. The total cost would be about £2,000, and about £1,600 had already been subscribed. The President of the Association thought the company would want about £600 more before it was floated. It was a question as to whether it should be worked by petroleum or steam, as electricity, he opined, was impossible for them to attempt.

Bury.—Councillor Barr was in a jocular mood at a meeting of the Town Council last week. He stated that he hoped the Electric Lighting Committee were up to date, and making preparations for using calcium carbide, which, with a little water added to it, gave forth an acetylene. In answer to the Deputy-Mayor, Councillor Barr said this was a practical outcome of science, and by that means they would have light—not heat—units at a small cost. It was thought that electric light was going to do away with gas, but by the means he had suggested gas and electricity would go hand in hand, and the result would be more light at less expense. The new light would give 240 c p. as against 9 c.p. derived from the gas light.

Rustproof Iron and Steel.—Our attention has been directed by the London Rustless Iron Company, of West End-lane, West Hampstead, London, N W., to the Bower-Barff process for rendering iron and steel articles proof against rust. The process, for the working of which the company have laid down plant at the address mentioned, is applicable to pipes, iron gates, balconies, railings, culinary articles, etc. In a paper on rust preventives presented by Mr. M. P. Wood to the American Society of Mechanical Engineers at the Montreal meeting in June, 1894, the author stated that some experiments on a small scale of the Bower-Barff magnetic oxide application to pipes and iron exposed to electrolytic action appear to indicate its ample protective power.

Kingswood.—The District Council last week had an interview with Mr. Edwards, who attended from the Bristol Tramway Company, and requested the Council to sanction an extension of the double line to be laid down in Regent-street. The suggestion was acceded to. Mr. Edwards then asked the Council if they would allow the company to place the feeder wire under the footpath, which course was preferable to its being under the road. The Chairman mentioned that they desired to minimise the number of poles in the road, and he asked whether the tramways company could not utilise the electric light or telephone poles? In reply, Mr. Edwards stated that the design was for the poles to be placed on the opposite side of the road, as there was less traffic there.

Plymouth.—During the discussion on a proposed tramway extension at a meeting of the Town Council on Wednesday, Mr. Radford said that he understood that the Works Committee had under consideration the construction of electric works of some kind, and suggested that the experiment of electric traction should be tried on the Ebrington-street line. He was in favour of the extension of the tramway system in that direction, but urged that the substitution of electricity for horse traction should be thoroughly considered. Mr. Debnam thought it was very early yet to talk of adopting electric traction. It might be possible to utilise accumulators for driving the cars by electricity in connection with the electric lighting works it was proposed to establish. Meanwhile he suggested that the committee should not erect additional stables, but, if necessary, hire.

Wednesbury.—The Highways, Market, and Stables Committee reported to the Town Council last week that the Board of Trade had granted an extension of time for the use of steam on the South Staffordshire Tramways for one month from February 15. Mr. Oldbury, in submitting the report, referred to the appointment of a committee by the Council at their last meeting to watch the interests of the town in relation to the trams. Communication had been made with the Board of Trade, and the inspector (Major Marindin) who conducted an enquiry a short time ago at West Bromwich had strongly recommended the local authorities in that neighbourhood to consent to the electric system. He was pleased that such an issue had been arrived at. In consequence of that recommendation, they would probably keep their communication with Birmingham from Wednesbury and Dudley.

Shoreditch.—The Vestry have now adopted the report of the Electric Lighting Committee which was originally made in July last. The Vestry propose that Messrs. Kincaid, Waller, and Manville be employed as consulting engineers to carry out the electric lighting and dust-destructor scheme, the contractors for the dust-destructor cells preparing their own plans and specifications upon requirements to be specified by Messrs. Kincaid, Waller, and Manville at a commission of 3 per cent. on the amount of the tender accepted on the original specification, no commission to be payable on extras, such commission to cover the preparation of plans and specifications, except as above stated, and the superintendence of the whole of the work as engineers to completion and advising on the acceptance of all tenders The contractors for the dust destructor shall also guarantee a specified amount of steam, but the consulting engineers will be responsible for the successful execution of the whole of the work.

Weston-super-Mare.—The Urban District Council on Wednesday discussed a recommendation of the Lighting Committee in favour of electric lighting being introduced into the town. In moving the adoption of the minutes, the chairman of the committee (Councillor Deverell) reviewed the action which had been taken in the past with a view to the electric light being introduced. Mr. Medhurst, the consulting engineer, appeared before the Council, and stated that he had offered to the committee to enter into a five years' agreement with the Council in regard to the proposed scheme. He would run all risks during the five years, and would make good any loss which might accrue (previously depositing £500 as a proof of his *bonâ fides*), on the understanding, of course, that any profits which might arise during the term should fall to him. Councillor Dubin, as an amendment, moved that the question of introducing the electric light be deferred for the present. On being submitted the amendment was carried by ten votes to five.

Bradford.—It was mentioned by Mr. W. C. Dixon (chairman of the Gas and Electricity Committee), at a meeting of the Town Council on Tuesday, that in the electricity department there was a total income of £6,349 in 1894 as against £5,642 in 1893, and a gross profit of £3,512 against £2,876 in 1893. The cost of working the plant had been £2,836 against £2,765 in 1893. After deducting from the gross profit, income tax, interest on loans, and sinking fund, there remained a net profit of £1,449 against £1,179 in 1893. A depreciation fund had been started, and £1,062 had been put to that account, leaving a balance of £387 against £1,179 in 1893. This sum of £387, with the balance from the previous half-year, made the total profits unappropriated on December 31, 1894, £2,817. The units consumed were, in the 1892 half-year, 224,232; 1893, 272,874; and in 1894, 307,977. The cost per unit per ton of coal had been: 1892, ·454; 1893, ·743; 1894, ·541. The average cost per ton of coal and coke used had been: 1892, 7s. 10¼d.; 1893, 13s. 1d.; and 1894, 8s. 1¼d.

Tunbridge Wells.—For the first time since the prolonged frost operations were last week commenced in connection with the electric light scheme. The central electric light station and works are also being rapidly pushed forward in the Corporation yard. Dealing with the question of electric lighting at a meeting last week, the Mayor said reference had been made to the appointment of an electrical engineer, and in considering who should be appointed they wanted a good all-round man, and he was glad to say that there were some excellent candidates. As regards the extension of mains he hoped applications would be sent in to the committee, in order that they might have some idea as to what the demands for the light outside the compulsory area were likely to be. As regards the price, he was strongly against 8d. per unit. It might be said that he did not practice in the City what he preached here, but they had not the difficulties in Tunbridge Wells which they had to meet in the City. If they charged 6d. they would make the electric light a still greater success, because

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more people would use it. The Corporation Lighting Committee have received a letter from Mr. Preece forwarding draft rules and regulations for house wiring, and a letter from Sir David Salomons with his observations thereon.

Hoole (Chester).—It was mentioned to the District Council last week by Mr. Duck that he had just seen the statement from the Chester United Gas Company, showing that the profits of the past year were something like £10,000. That was a handsome profit for a company to make, and he rose for the purpose, seeing that the Chester authorities were moving in the matter, of proposing that the question of electric light for Hoole should be referred to the Works Committee. The city was moving cautiously and wisely in the matter, and suggestions had been made that they should provide the light themselves. It was a great injustice that the Chester Gas Company should charge them 2d per thousand more than the Saltney Parish Council. Considering the splendid position they were in, they at least ought to put them even on the same terms as the city. Their Works Committee might also consider whether it was practical and advisable to provide the electric light themselves. Mr. Nightingale seconded, and the motion was unanimously passed. In answer to the chairman, Mr. Ewing (the surveyor) stated there were 70 lamps in the district.

Dublin.—The work of rebuilding the Southern District Tramway Company's line between Haddington-road and Dalkey was commenced on Monday under the superintendence of Mr. J. C. Robinson, managing director and electrical engineer of the company, and Mr Mossop, representing the British Thomson-Houston Company, Limited. The total estimated cost of the reconstruction and equipment of the line amounts to £109,200. Mr. August Krauss, of Bristol, has been entrusted by the Thomson-Houston Company with the construction of the permanent way. Ornamental steel standards will be erected on the kerbstones of the footpaths on both sides of the road opposite to each other, and 24ft. above the ground level will be suspended the cross or span wires from pole to pole. These standards will be placed at a distance of 125ft. apart along the whole line. Two trolley wires will be held in position by insulators from the span wires directly over the centre of each track throughout. The station for the generation of the electric power will be erected at Ballsbridge on the premises at present used as the company's horse car depôt. The new cars will be somewhat similar in pattern to those hitherto in use, but will be of more improved form and construction, having seating capacity for 50 passengers, 24 inside and 26 outside.

Newport (Mon.).—A question was asked by Mr. W. H. Brown at a meeting of the County Council on Tuesday as to when the borough would be put in possession of the electric light installation. Alderman Moses explained that the wet weather, followed by the month's frost, had tended to cause delay, and that the contractors, and especially the contractor for the large engines, were also behind. He hoped the works would be completed in about a month or six weeks; and that the day plant, providing for about 900 lights, would be ready in a week for those who were immediately in want of the light and for the Town Hall. The wiring of the Town Hall would be completed in a fortnight or three weeks. Mr. Mordey asked whether the foundations for the engines were ready, and, defending the contractor for the engines (a local firm), said there were other and strong reasons for the delay. Mr. Greenland hoped the committee would not be hurried over the electric supply, because it was very desirable that when a start was made it should be effective. He had been waiting some little time for the light at his establishment, but should be quite content to wait a little longer. Alderman Moses said the foundations were quite ready, and confessed that he did not understand Mr. Mordey's remarks about other reasons, and so forth. He had no other reasons he could give except what he had stated.

Burton-on-Trent.—In our last issue reference was made to the report of the Gas and Electricity Committee of the Town Council. Alderman Lowe, in moving the adoption of the minutes said the committee had received from the borough accountant a balance-sheet concerning the electric lighting during the past year. It was anticipated—at least, provision was made on the rate for it—that there would probably be a loss of £2,250. Of course they were all sorry to contemplate a loss so great as that, but he was glad to say it was much less, the actual figures being £1,802. 9s. 3d., so that they were better off by £450 than they anticipated 12 months ago. The working expenses for the year were £843 in round figures, while the receipts for electric lighting were £528, so that the actual loss on the working was £315. He had no doubt whatever that if they got as many consumers as they were able to supply with the electric light, there would be no loss on the general trade. What made the great difference was what was usually called the paying back of principal and interest on the loan; and he was afraid for some time to come, unless some cheaper way might be devised for producing the electric light, they might not be able to pay the dividend and redemption fund, though they might be able to pay the working expenses. Although they had the electric light, the consumption of gas did not decrease, but increased, and what was the most surprising was that it should have taken place after the price was raised.

Southport.—The minutes of the Electricity Committee presented to the Town Council on Tuesday contained a report from Prof. Kennedy with respect to arc lighting. Dealing with street-lighting, he said there was no doubt that the only satisfactory way of using electricity for this purpose was by means of arc lamps. In many instances, however, he had found that the cost of electricity in this form would be something like four times the cost of gas for a given length of street. On the other hand, the amount of light given by the arc lamps was more like 20 times as much as that given by the gas lamps which they replaced. The cost per lamp per annum would be something like £20, supposing that half the lamps were turned out at midnight, while the others burned until sunrise. After considering Prof. Kennedy's report, a sub-committee visited Portsmouth to inspect the rectified-current lamps in use there. They expressed the opinion that these rectified-current lamps were perfectly satisfactory from a lighting point of view, and they recommended that Lord-street and the Promenade should be lighted by 40 electric lamps supplied with rectified current The committee resolved that the report and recommendation be adopted, and that the sub-committee be instructed to proceed with the work forthwith. Councillor Hesford moved and Councillor Todd seconded the adoption of the minutes. The motion was carried. Prof. Kennedy has also recommended the laying down of two direct-driven alternators, each of 100 units capacity.

Bristol.—The electric light is to be introduced in the cathedral. It is proposed by the Visiting Committee of the Bristol Lunatic Asylum to light the latter building by electricity. The Bristol Sanitary Committee had under consideration last week a report by the surveyor that under the first schedule the tramways company had submitted designs of the proposed posts for West-street, Clarence-road, and Lawrence hill, for the purpose of carrying the wires for the electric tramways. The company also asked that the iron junction-boxes, 18in. by 13in. and 48in. high, might be placed one in the west end of Old Market-street and one in Clarence-road, opposite Trinity Church. The surveyor reported that with regard to the boxes there did not seem any provision for them in the schedule referred to. In answer to Mr. Todd, the surveyor explained that one post provided for a lamp, which might be used for electric lighting, and the other plan dispensed with a light, but had ornamental ironwork. The Chairman said they had power to appoint someone to superintend the work on behalf of the Corporation, and charge the cost to the tramways company. It was agreed that the surveyor should confer with the Electrical Committee in order that provision might be made to look after the interests of both committees and to pass the plans. The Electrical Committee of the Corporation have instructed their secretary to ascertain the amount of support likely to be given if the electric light mains are carried through certain districts in time to be used next winter.

Keswick.—The Urban District Council last week received Mr. Shipp, the engineer of the electric light company. Mr. Shipp said the first question was as to whether arc lamps or incandescent lights should be put up. The proposition was that three arc lights, of about 500 c.p. each, should be erected, but he suggested that it would be better to have incandescent lamps. His directors were suggesting the incandescent lamps more for the benefit of the town than their own. Mr. Wood then read a letter from the directors of the electric light company referring to the undertaking, subject to the approval of those who were introducing additional capital into the company, to give three lamps to the town, and stating that they had been advised by the Hon. C. Parsons that such condition was altogether unheard of and an insuperable obstacle to the proceeding with the enlargement of the station. They felt the great difficulty in which this decision would place the company, and three of their directors had visited Newcastle to interview Mr. Parsons and Mr. Harvey, his solicitor, and they found that unless the Keswick Council would give their unqualified consent to the application for the provisional order, they would be precluded from assisting the company in enlarging the station and putting down plant necessary to ensure a constant supply of light to the customers. Under these circumstances the directors felt they must ask the Council to comply with their request, or they would have no alternative but to call their shareholders together with a view to winding up. Messrs Mumberson, Pape, Philipson, Milburn, and Highton were appointed a committee to go into the matter.

Chester.—The Town Council had brought before them on Wednesday a recommendation from the Electric Lighting Committee that they should be authorised to accept the tenders submitted for engines, boilers, and dynamos, amounting to £8,518. Mr. W. C. Deeley, as chairman of the committee, brought forward the recommendation, but explained that he did not agree with it. He condemned the idea of accepting tenders from different people in consequence of the great difficulty of coupling different makes of machinery together. They ought to go to some well-known firm and get them to put up the whole system, and give a guarantee that they would run it for at least 12 months to the satisfaction of the Corporation. He complained that Dr. Hopkinson had disregarded the instructions of the committee in not sending out for tenders on the Oxford system. The committee had sufficient information which showed that electrical energy could be supplied at a less cost, or, at any rate, the same cost as the ratepayers were now paying for gas; but he thought that if the Council went in for a low pressure system without being able to carry it further than the compulsory area, they would be guilty of a great error. Mr. B. C. Roberts, in formally seconding as deputy-chairman of the committee, said the action of the committee was inconsistent, and their scheme was incomplete. In June last they passed a resolution that the electric lighting should be on the high-pressure system and all along it had been understood they were going in for the high-pressure generating system. Alderman L. Gilbert also condemned the scheme. He said that Dr. Hopkinson's system was to cost £22,000, while Mr. Preece had estimated that it could be done for £15,000. The Watch Committee, before the Electric Lighting Committee were called together, got 13 tenders, and only one of them exceeded £15,000. He moved as an amendment that the matter should be

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referred back to the committee, with instructions to treat with some firm or firms for the lighting of the city, and, failing to make satisfactory terms, to bring to the Council plans, specifications, and tenders for a complete scheme, and that it should be an instruction to the committee that any firm or firms tendering shall undertake to run it for a given time. Mr. R. C. Davies seconded the amendment. The Mayor spoke strongly in support of the recommendations, defended Dr. Hopkinson, and pointed out that under his scheme it was possible to supply the light to the whole of the city. He asked the Council to trust the engineer they had called in, and leave to him the responsibility. The amendment was then put and carried by 21 to 9 votes. The Council then resolved to ask the Local Government Board to sanction the Council borrowing up to £25,000.

Yarmouth.—The borough surveyor (Mr. J. W. Cockrill) reported to the Town Council on Tuesday that the present amount of arc lighting in the streets would cost £700, as against gas £500 per annum. The public lamps were alight by the card 3,032 hours per annum, and at a charge of £700 the cost was rather more than 3s. 6d. per hour for all the lamps in the town. The lamps were alight 684 hours in January and February, and upon that basis the income was £185, including an item of £60 for 2,404 units supplied to customers at 6d., and the expenditure £243, showing a loss on working of £57. The items of expenditure did not include the cost of house connections and extensions, which would come out of the capital account. The customers were now being rapidly connected, and he had every confidence that the accounts would soon balance themselves, and show some signs of a contribution towards interest and repayment of capital account. Twelve additional customers had applied for 627 lamps, making the total number of lamps 3,095, and as the average earning power of each 8-c.p. lamp throughout the country was 10s. per annum, a sufficient number of lamps had been applied for to pay the whole cost of working. A fair estimate of the year's working was—income, £2,376, and expenditure, £1,710, leaving £666 available towards paying interest and redemption of capital. The Borough Surveyor stated that the borrowing powers of the committee would be exhausted before the present contracts were completed, and large sums were now being expended in providing meters, transformers, and additional mains, and that a considerable amount would be needed in the future The Council were recommended to apply to the Local Government Board for a loan of £2,000 for these purposes. The report was adopted.

Cardiff.—The Lighting and Electrical Committee of the Corporation met on Tuesday for the purpose of considering applications for the appointment of a practical man to take charge of the electric lighting station. The Mayor (Alderman P. W. Carey) presided, and there were also present Councillors T. Hurry Riches and W. Evans, Mr. W. Harpur (borough engineer), and Mr. W. H. Andrew (clerk). There were 38 applicants for the post, and out of this number the following were selected to appear before the committee: Wm. M. Huskisson, A.I.E.E., Ladbroke grove, London; Neville Applebee, Stafford-place, Buckingham Gate, London; Clement W. Sully, Burnham, Somerset; and Joseph Bastick, Granvilla-terrace, Chelmsford. The Mayor stated that these gentlemen would be asked to attend their ordinary meeting on Tuesday next. Councillor T. H. Riches said that he desired to say something about the present state of the electric light. He felt very sorry about the whole proceedings, and thought that serious steps should be taken to put the matter right. They had two valuable machines there which were rendered quite inoperative because the engines attached were inefficient. Then, again, they were spending £200 a year on these rectifiers, whereas if they had carried them to the station and put them on separate circuits they would have saved the interest on £5,000. The Mayor said that Mr. Riches must admit that all the new stations put up had gone in for rectifiers. Councillor Riches replied that that was so where they had been put up with an object in view, but these were not adapted to the rectifiers. At Portsmouth they were designed for the purpose. The Mayor said that they had got the best manufacturers of machinery in the world. Councillor Riches remarked that candidly he did not think there were better manufacturers than Messrs. Siemens in the world. They must not forget this, that Messrs. Siemens were to find certain plant, and they left their hands entirely free, but as far as the engines were concerned there were certain fads attached to it. It was no use running electrical plant on that system at all, unless they had a machine that could run it, and the sooner they took it off the better. The machines were not at all adapted to the work. To say that the system was wrong was absurd, with all due respect to the statements in the papers. The Mayor stated that rectifiers had been used successfully at Portsmouth, and been adopted at four or five stations recently put up. Councillor Riches said that if their electrical plant had been designed for the purpose it would have been all right. He was of opinion that it would be far better for the committee to alter the arrangement, and put down the plant as it should have been and settle it. They would save the wages of the men who had to look after the rectifiers. The Mayor did not know of any place in England where a more perfect light was going forth. The Mayor then referred to Mr. Massey, their engineer, saying that he was £1,400 out of pocket over the work. Mr. Riches said that Mr. Massey was an old friend of his, but he was bound to say what he felt was the truth, and he said it without wishing Mr. Massey any harm or without intending to offend anyone. He had been told that Messrs. Siemens were very vexed about the matter. Councillor Evans asked, if the rectifier was not of any service, had it not better be done away with? Councillor Riches did not want them taken away until Mr. Massey had tried experiments. Mr. Harpur remarked that a good deal had been said about this matter, but he felt very sanguine himself that it would come all right. In that morning's papers writers stated that they were not getting customers; but he would like to mention that they had already over 4 000 lamps wired at present, and were constantly getting more. He thought this exceedingly good. Further discussion followed, and ultimately the matter was adjourned to the next meeting.

The Rhondda.—In the course of a communication to a Cardiff paper on the proposal to light Rhondda Valleys by electricity, Mr. S. F. Walker says: The scheme I venture to propose will, I believe, commend itself to nearly everyone who will think the matter out for himself. The Rhondda Valley and its tributaries form one of the few districts for which high-tension alternating currents present special advantages. A single station might be established at the junction of the two valleys in the neighbourhood of the Cymmer Colliery, high-tension machines, furnishing alternating currents, with the necessary engines, boilers, and other accessories being laid down there. The high and low tension cables, the lamps for the public service, and the transformers might be carried on ornamental iron posts, placed on the sides of the roads. From the position I have indicated, cables could be carried on each side of the valley right up to Blaenrhondda, in the Rhondda Valley, to Maerdy, in the Rhondda Fach, down to the outskirts of Pontypridd, across to Ynysbwl, and up the Clydach and Dinas Valleys. In fact, the whole district could be easily covered. Two sets of posts might be fixed on each road, one set on each side of the road, each having its own supply cables leading right into the generating station; and the public service lamps would be placed alternately on opposite sides of the roads, so that all could not easily be extinguished together. The high-tension cables should all be insulated, and carried right to the tops of the posts, so that there would be very little danger of either leakage or shock from them; the low-tension cables being carried on the same posts, but well away from the high-tension cables, and also well insulated. If it was decided to provide a consumers' supply service also, the cables necessary for this could be added from time to time, as the demand increased, proper provision being made for them on the posts. A certain number of the posts also would be specially designed to carry the transformers, which would be placed well out of the way of both the careless and mischievous, carefully insulated and carefully protected from mischief, accident, and weather. If it was desired later on to run trams by electricity over a portion of the road it would be perfectly practicable to use the same poles for an overhead trolley service, with a modification of the plan so largely adopted in America; additional dynamos being laid down for the purpose, and other arrangements made that can easily be worked out when required. At the place I have named the coal consumed would be as cheap as if it were burnt at the several collieries, and if arrangements could be made to use the gases from a set of coke ovens, or from one of the blowers in the neighbourhood, to fire the boilers, the power would be obtained at a very cheap rate indeed. Water is abundant, and the engineer would not be troubled about the disposal of his ashes any more than the collieries are.

Brighton.—The Town Council last week adopted the statement of accounts which we published in our last issue. In moving the adoption of the Lighting Committee's report containing the accounts and recommendations, Councillor Stafford said he was very pleased to be able to report that the forecast which the committee gave some time ago was not exaggerated. The financial statement had been prepared by the borough accountant, and was vouched for as being absolutely correct. Those who had read Mr. Wright's exhaustive report as to the future price the committee should charge, would undoubtedly agree with the committee's resolution to charge 7d. for the first hour per day and 3d. afterwards. This would be a sweeping reduction, and would enable 87 per cent. of their customers to benefit by the change, whereas during 1894 50 per cent of their customers did not benefit by the reduction made. A very large number of their customers were tradespeople, who, on the average, used the supply two hours per day, and, therefore, in 1894 derived no benefit, but on the new scale their bills would be reduced about 28 per cent., private houses benefiting in like manner. Those using the light more than two hours per day would get a still further reduction, and he was satisfied that hotels would find the electric light from the Corporation much cheaper than any other system. The average price for electricity during the current year would not be more than about 5d. per Board of Trade unit. Congratulating the Council on the great success of the undertaking, Councillor Stafford said the committee visited the works in a body, and saw for themselves the admirable, careful, and profitable manner in which the undertaking was managed by their engineer, Mr. Wright, and were unanimous in their praise and satisfaction with his electrical skill and commercial ability—two qualifications not always to be found in one man. He unhesitatingly said that to Mr. Wright's able management and his system of demand and sliding scale charges were due the result of last year's working. He had absolute confidence in Mr. Wright's integrity and conscientiousness, and believed him to be above suspicion, and, therefore, had great pleasure in recommending the Council to increase his salary from £400 to £600 per annum. The enormous reduction in the price this year and the consequent increased load on the plant would, he believed, make Brighton the pioneer of cheap and profitable electricity, and ultimately enable them to offer the illuminant to the million as cheap, if not cheaper, than any other light. Electricity had never been produced at as low a total cost as the committee did in 1894—viz., 2½d. per unit—not-

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withstanding the many stations having a very much larger sale, and their having to pay on the average nearly 21s. per ton for coal. Councillor Halliwell said the committee, in reducing the rental of the meters, was making a great concession, but he suggested that it would be a great boon and benefit to the concern if they abolished the charge altogether to consumers of over an hour a day. Councillor Costerton also suggested that there should be a stated charge for which consumers who believed their meters did not register correctly could have their meters tested or verified. He had been informed it might be done for 10s. 6d. Councillor Galliers said there was a fixed charge. Councillor Stafford, replying upon the discussion, pointed out as to the undertaking paying, that, in addition to the amount of the net profits, they had paid £2,351 to the redemption fund and £2,663 for interest. As to the suggestions of sweating, they paid the regulation wages and overtime, and he was perfectly certain that every man there was satisfied. As to the meter-testing, their rule was that in case of complaint a meter was examined, and if found to be correct, a fixed charge of 10s. was made, simply to cover the expenses; if the meter was incorrect, that charge was not made. As to meter rents, he pointed out that in the cases of certain small consumers they would have no means of making the undertaking pay if they did not exact a rental for the meters. He asked the Council, in regard to the recommendations now put before them, to have confidence in the committee, and the proceedings, on being put to the vote, were agreed to.

PROVISIONAL PATENTS, 1895.

MARCH 4.

4551. **Electrical cut-outs.** Ernest Alexander Claremont, Cooke-street, Hulme, Manchester. (Complete specification.)

4557. **Conduit electric railway.** Leonidas Calvin Pressley, 60, Queen Victoria-street, London. (Complete specification.)

4576. **Improvements in electric motors.** Archibald H. Brintnell, 323, High Holborn. (Complete specification.)

4577. **Improvements in or connected with apparatus for electrically lighting miners' safety lamps.** William Ackroyd and William Best, 33, Chancery-lane, London.

4593. **The pen's electric illuminator.** Henry William Cobb, 28, Hollyoake-road, Newington-butts, London.

4610. **Improvements in or relating to secondary batteries or electric accumulators.** Wilheim Alexander Boese, 6, Lord-street, Liverpool. (Complete specification.)

MARCH 5.

4623. **Electrical method of closing the air-exhaust apertures of hermetically sealed canisters and like vessels.** George William Davey, Bristol Bank-buildings, Bristol.

4660. **Improvements relating to the electro-deposition of iron on copper or other metallic surfaces.** Arthur Hiorns, 18, Southampton-buildings, Chancery-lane, London.

4670. **Improvements in electric apparatus for igniting and extinguishing gas jets simultaneously from a distance.** Oscar von Morstein, 89, Chancery-lane, London. (Complete specification.)

4672. **Improvements in telephone and telegraph systems.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Christopher Ambrose Shea and Freeborn Fairfield Raymond, United States.)

4685. **Improvements in commutator brushes.** Francis Henry Louis Blanken, 37, Chancery-lane, London.

4697. **Improved electric signalling apparatus for railways.** Gustav Adolph Lyncker and Anton Schropp, 18, Buckingham-street, Strand, London. (Complete specification.)

MARCH 6.

4716. **Improvements in and relating to phonographs and similar sound-recording and sound-reproducing instruments.** Horatio John Heinzie, 16, East-road, City-road, London.

4770. **Improvements in apparatus for measuring electricity.** Edward Howard Percy Humphreys, 55, Chancery-lane, London.

MARCH 7.

4851. **Automatic replacement fuse for electric lighting.** William Cole, 80, Franche Court-road, Lower Tooting, London.

4873. **Improvements in connection with electrical insulating materials.** Tressillian Percy Wiggins and George Herbert Wiggins, 36, Chancery-lane, London. (Complete specification.)

MARCH 8.

4939. **Indirect electrolysis.** Emile Androli, 47, Lincoln's-inn-fields, London. (Complete specification.)

4941. **Improvement in pushes for electric bells.** Richard John Dale, 60, Queen Victoria-street, London.

4979. **Improvements in wall plugs for electrical connections.** Henry Wilson Young, 1, Queen Victoria-street, London.

4980. **Improvements in dynamo-electric machines and motors** Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

4987. **Improvements connected with arc lamps.** John James Rathbone and the "Harp" Arc Lamp Syndicate, Limited, 166, Fleet-street, London.

MARCH 9.

16156A. **Improvements in electric locomotives chiefly designed for use in mines.** Bruno Lebrun, 45, Southampton-buildings, Chancery-lane, London. (Date claimed under Patents Rule 19, August 24, 1894.)

5003. **Improvements in electric condensers.** Sebastian Ziani de Ferranti, 27, Charterhouse-square, London.

5004. **Improvements in apparatus for regulating and controlling electrical circuits.** Harold Dickinson, 25, Ella-street, Blackman-lane, Leeds.

5031. **Improvements in electricity meters.** Francis Fane Yeatman, The Island, Reading.

5041. **Electric steering gear.** Siemen Bros. and Co., Limited, and George Sylvester Grimston, 28, Southampton-buildings, Chancery-lane, London.

5058. **Improvements in or applicable to electric arc lamps.** Robert James Rae, 4, South-street, Finsbury, London.

5059. **Improvements in and relating to electric accumulators.** Alfred Oblasser and Charles Théryc, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1891.

13503 **Electric machines, etc.** Von Dolivo-Dobrowolsky and others. (Second edition.)

1893.

21714. **Electric exchange systems, etc.** Williams.

1894.

7080. **Phonographs.** Oulton.

7155. **Electric cut-out.** Higgins.

7165. **Secondary batteries.** Clubbe and Southey.

7240. **Electrically-propelled vehicles.** Bersey.

8808. **Electric batteries.** R. McL. and A. McDonald. (Second edition.)

11069. **Submarine telegraph cables.** Muirhead.

1895.

545. **Electrical switches.** Dorman and Smith.

1000. **Electric railways.** Dulany and Shaw.

1088. **Electric fuses.** Siemens Bros. and Co., Limited, and Hird.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅝-2⅝
—— Nom. Cum., 6 per cent. Pref.	2	2⅝-2⅝
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	15-15½
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	130-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	3-3½
—— 5 per cent. First Mortgage Debentures—1400 of £100 and A, 1-200 of £50	100	102 107
Electric Construction, Limited	2	½-⅝
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1½-1⅝
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1½-1⅝
Elmore's French Company	2	—
Elmore's Wire Company	2	1½-1⅝
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	10-11
—— Preference	—	12
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	7½-7⅝
India Rubber and Gutta Percha Works	10	22½-23½
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅝-7⅞
—— Pref.	—	—
Liverpool Overhead Railway	10	8½-8⅝
—— Pref.	10	13½-14
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	½-⅝
Metropolitan Electric Supply	10	10½-11
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5½-5⅝
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7½-7⅞
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5½-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7½-8
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7½-8
Yorkshire House-to-House	5	4½-4¾

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NOTES.

Hobart Electric Tramway.—It is stated that this electric tramway is paying well.

Personal.—Mr. Neville Applebee, of London, has been appointed electrical engineer-in-charge of the Cardiff central station.

Light and Heat Exhibition.—This exhibition, in consequence of the recent long-protracted frost, has been postponed for a few months.

French Cable.—A cable, 25,000 metres in length, has just been finished at Seyne, and will shortly be taken to Madagascar by the English chartered transport.

Lecture.—Prof. W. Robinson, M.E., delivered the first of a course of three lectures explanatory of "The Work of the Electric Current," at the Nottingham University College on Friday.

Lighthouse Illuminants.—A paper on this subject was read last week by Mr. John R. Wigham at a meeting of the Shipmasters Society held at the offices of the London Chamber of Commerce.

Building Trades Exhibition.—Prof. Henry Robinson is announced to lecture on "Electricity" at this exhibition, which will be opened at the Agricultural Hall, Islington, on Monday next.

Royal Meteorological Society.—At the meeting of this society on Wednesday evening, Mr. W. N. Shaw, F.R.S., delivered a lecture on "The Motion of Clouds Considered with Reference to Their Mode of Formation."

Heilmann Locomotives.—It is stated that the two Heilmann locomotives now being constructed for the Western Railway Company of France for express service between Paris and Dieppe, are to be ready next June.

Queenwood College.—We have received a card of the fixtures for the spring term at Queenwood College, near Stockbridge, Hants, controlled by the Queenwood Association for promoting the study of literature, science, and art.

City and Guilds of London Institute.—The institute's examinations in technology will be held on April 27, May 1, 4, 6, 8, and 9. All applications for examination in technology must be forwarded to the institute on or before April 1.

Institution of Electrical Engineers.—A paper by Mr. W. E. Langdon (member) "On the Employment of the Electric Light for Railway Purposes," will be read at the meeting of the institution to be held on Thursday next, the 28th inst.

Telephony between Holland and Belgium.—It is stated that an agreement has been signed between Holland and Belgium for the establishment of telephonic communication between the two countries. The first line between Brussels and the Hague will be opened on July 1.

Lighting of the Embankment.—In the London County Council (Money) Bill power is sought, among numerous other purposes, to light by electricity the Victoria-embankment, the embankment gardens, and Waterloo and Westminster Bridges, and to acquire tramways.

The Faraday Medal.—The Faraday medal of the Chemical Society has been conferred upon Lord Rayleigh in recognition of the investigation which has led to the discovery of argon. The previous recipients of the Faraday medal are Dumas, Canizzaro, Wurtz, Helmholtz, and Mendeleeff.

The Pacific Cable Question.—A telegram from Victoria (British Columbia) states that according to advices from Sydney, Mr. Larke, the Canadian agent, is of opinion that the laying of the Pacific cable is assured, provided that England assumes her share in the undertaking. Mr. Larke considers the prospect of business with Canada a good one.

New Editions.—Messrs. Whittaker and Co. announce the issue in a few days of a revised and enlarged edition of Poole's "Practical Telephone Handbook," and a third edition of "Electricity in our Homes and Workshops," by Sydney F. Walker, revised and brought up to date. A new addition of Allsops' "Practical Electric Light Fitting," has recently been issued by the same publishers.

"D. and S." Electric Lighting Accessories.—A February list of their accessories for electric lighting has been forwarded to us by Messrs. Dorman and Smith, of London, Manchester, and Glasgow. This particular list illustrates the "D. and S." porcelain switches, main switches, ceiling roses, cut-outs, wall sockets, lamp holders, brackets, and general fittings and main switchboards.

Electric Tramways in Paris.—A Paris correspondent states that the rejection of the metropolitan scheme by the Municipal Council has increased the problem of locomotion, which will have to be solved before 1900. So far the only proposals made are for the construction of new tram lines with an electric service within the precincts of the exhibition, and the building of new steamers for the Seine.

Leeds Tramways.—The Leeds Corporation intend to apply to Parliament, by way of petition for additional provision, for the insertion in a Bill now pending in the House of Lords of clauses to empower the Corporation to construct stations for generating electric power for the purpose of propelling carriages on the tramways, and to lay down dynamos, engines, and other apparatus for the working of tramways.

City and South London Railway.—The Bill, which seeks an extension of time until 1900 within which to enable the City and South London Railway to construct the authorised extension of their electric railway from Stockwell to Clapham, was on Wednesday referred to the Unopposed Bill Committee of the House of Commons, a settlement having been effected with the Lambeth Vestry, which was the only opponent.

Electricity in Mining.—In the annual report of inspectors of mines, Mr. Robson, of the South Wales district, states that the application of electricity to mining purposes continues to make steady progress, especially as a means of transmitting power. He has no reason to doubt that, with due care in the erection of plant and especially in the insulation of cables, electricity will afford a large measure of safety.

New Zealand.—The New Zealand Electrical Syndicate are receiving good support in Wellington, as is shown by the rapid increase in the number of installations. In October, 1893, only 700 lights were supplied to the public, whereas at the present time the number is about 8,000. The post and telegraph offices are being fitted throughout. It is anticipated that orders will shortly be received to instal the electric light in all the other Government offices.

Electric versus the Welsbach Light.—A correspondent informs us that a firm of Liverpool shipowners, who formerly had their offices lighted throughout with gas, burnt through Argand burners, desired to introduce some better means of illumination, but did not wish to have the electric light installed. The firm gave the Welsbach system

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a trial, but after about two months' use they voted it as unsatisfactory, and at once gave orders for the electric light to be installed throughout.

Royal Society.—Among the papers down for presentation at yesterday's meeting were: by Lord Kelvin, P.R.S., and Messrs. M. McLean and A. Galt, "The Diselectrification of Air"; by Prof. V. B. Lewes, "The Cause of Luminosity in the Flames of Hydrocarbon Gases"; by Mr. E. C. C. Baly, "A Possible Explanation of the Two-fold Spectra of Oxygen and Nitrogen"; and by Messrs. A. W. Porter and D. K. Morris, "On the Question of Dielectric Hysteresis."

Northern Society of Electrical Engineers.—A smoking concert of this society will take place this (Friday) evening at the Palatine Hotel, Hunt's Bank, Manchester, commencing at 7·30 p.m. The following gentlemen were elected members at the meeting of the society held in Liverpool on the 11th inst.: Mr. E. W. Dickinson, Corporation Electricity Works, Bolton; Mr. D. C. Jolley, Corporation Electricity Works, Manchester; and Mr. W. H. Preece, F.R.S., C.B., Wimbledon.

Shot Firing in Mines.—Mr. Roskill's report on the Albion Colliery explosion will be published forthwith. An analysis of the case, signed by Mr. Robson, Mr. Hall, and Mr. Martin, inspectors of mines for the South Wales, the Liverpool, and the South-Western districts respectively, is appended to the report. In concluding their report, the latter take the opportunity to impress upon owners and managers of mines the urgent necessity that exists for dispensing with the use of explosives as far as possible, and to suggest that where explosives are used only the safest that can be obtained should be allowed. It is also recommended that all shots should be properly tamped with clay and fired by electricity.

Telephone Tax.—A strange restriction, the *Financial Times* states, of the privileges of members of the Stock Exchange has just occurred. For some time past they have had the free use of a telephone which connects the building with the offices of brokers, but within the last few days a new regulation has come into force, and now only subscribers of £5 have entry to the telephone-room. Apparently the only object of the rule is a tax, for if it were intended to prevent a broker from advising his clients, at their offices, as to changes in prices and the course of business, the imposition of a charge of £5 a year could hardly be expected to prove an effectual obstacle.

Cable Rates to South Africa.—A *Times* correspondent states that the negotiations, to which we referred in our last issue, between the Eastern Telegraph Company and the Cape, Natal, and Transvaal Governments and the Chartered Company for the reduction of the cable tariff have been concluded. Public messages will pay 5s. a word from April 1. The new agreement is to extend for 10 years after 1899, power being reserved to the Government to determine the agreement by 12 months' notice expiring five years after the begining of the extended term. The Cape will continue to pay the present subsidy of £15,000 a year until December, 1899, after which the subsidy will be £6,000 a year. The new rates are applicable to all countries in South Africa which are under British and Dutch jurisdiction.

Committee on Telephony.—As foreshadowed in our last issue, the following have been nominated as the Select Committee on telephone service: Captain Bagot, Mr. Baird, Mr. Benn, Sir C. Cameron, Mr. John Ellis, Sir J. Fergusson, Sir J. Goldsmid, Sir J. Gorst, Mr. Grant Lawson, the Solicitor-General, Mr. A. Morley, Mr. Moulton, Mr. Snape, Lord Stanley, and Mr. Tully. The committee have power to send for persons, papers, and records. The committee met on Tuesday and elected Mr. Arnold Morley as chairman. The committee will meet for the first time to-day (Friday) at 11.30 a.m., for the purpose of taking evidence, and afterwards on Tuesdays and Fridays. The first witness will be Mr. C. J. Lamb, the head of the Telegraph Department at the Post Office, and afterwards Mr. Provand, M.P., will be examined.

Royal Institution.—Among the lecture arrangements after Easter are the following: Prof. George Forbes, three lectures on "Alternating and Interrupted Electric Currents"; Prof. E. Ray Lankester, four lectures on "Thirty Years' Progress in Biological Science"; Prof. Dewar, four lectures on "The Liquefaction of Gases"; Dr. William Huggins, three lectures on "The Instruments and Methods of Spectroscopic Astronomy" (the Tyndall lectures). The Friday evening meetings will be resumed on April 26, when a discourse will be given by Dr. John Hopkinson on "The Effects of Electric Currents in Iron on its Magnetisation." Succeeding discourses will probably be given by the Earl of Rosse, Veterinary Captain Frederick Smith, the Hon. G. N. Curzon, M.P., Prof. Walter Raleigh, Mr. J. Viriamu Jones, Prof. Alfred Cornu, and other gentlemen.

Explosions in the Streets.—The Highways Committee of the London County Council were on Tuesday asked by Mr. Fletcher whether the committee had had under consideration the explosions which had taken place in the streets in connection with electric lighting. In reply, Mr. Edwin Jones stated that the Council had opposed the action of the Board of Trade in giving its sanction to the new transformer-chambers, and that the only course now open to them was to apply for an injunction to restrict the carrying out of such works. They had had five of these explosions during the last three or four months, two of them since the Board of Trade gave its decision in this matter, and he thought the responsibility for all future accidents that might take place would rest mainly with the Board of Trade. The Highways Committee can very well leave the matter in the hands of the Board of Trade.

Madras Tramways.—The Madras Electric Tramway, the *Indian Engineer* states, is an accomplished fact. Very successful trial trips have been made, and the first section is about to be, if it is not already, opened to traffic. This latest departure in the methods of traction employed in this country must needs be of interest to all, and the working of the tramway will be closely watched. There is really no tangible reason why electric traction should not succeed in India as well as it has in any other country; if it is only from a humanitarian point of view, it deserves to succeed in order to obviate the use of horses. It is but a sorry spectacle under the very best of circumstances, to see a heavily-ladened tramcar dragged through the intense heat of a Calcutta hot day, by a pair of unfortunate animals, though it must be admitted that every effort is made to render their task easy. Now that Madras has given the lead there should be no difficulty in other cities following.

City Electric Athletic Club.—This club, which was instituted in connection with the City of London Electric Lighting Company, Limited, will hold its third annual bohemian concert at the St. James's Hall (banqueting room), 73, Regent-street, W., on Tuesday next, the 26th inst., commencing at 7.45 p.m. The chairman will be Sir David L. Salomons, Bart., president of the club. The following will contribute to the programme: artistes—Miss Lily Seddon, Miss Florence Venning, Mr. Geo. S. Aspinall, Mr. Stuart Walker, and Mr. Alexander Tucker; musical

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sketch, Mr. Walter Banks; recitations, Mr. Valentine Hill; humorous songs, Mr. Ambrose Thorne; ventriloquism up-to-date, Mr. Frederic Russell; cornet solos, Mr. L. Hawkins (H.A.C.); clarinet solos, Mr. James Hubert (late Coldstream Guards); accompanist, Mr. Tom Physick. There will be an orchestra of 30 performers. The Concert Committee are Messrs. H. Bacon, E. J. Frowein, and A. F. Harrison, 1 and 2, Great Winchester-street, E.C.

Telegraphic Cede Vocabulary.—The Postmaster-General, in reply to a question put in the House of Commons last week, stated that it was decided at the last International Telegraph Conference, held in Paris in 1890, that an official vocabulary should be compiled, and that the use of words taken from that vocabulary should be made obligatory for code telegrams in the European system at the expiration of three years from the date of issue of the book, but the employment of the vocabulary outside that system was left optional. The three years would expire on December 31, 1897. This country and its colonies being parties to the International Telegraph Convention, and the adoption of an official vocabulary having been decided upon by the union, it would not, he feared, be possible for him to accede to the suggestion that British merchants should be secured a continuance of the privilege hitherto enjoyed of using their own vocabularies, provided that they contained only words taken from the eight authorised languages.

Metric System of Weights and Measures.—The Select Committee of the House of Commons on weights and measures met again on Tuesday, when Mr. Alfred Spencer, chief officer of the Public Control Committee of the London County Council, was called. He stated that the Council were independent of the Board of Trade and appointed their own inspectors, who, however, had to pass a Board of Trade examination. As to the difficulties of a change of system, he mentioned that the County Council had made enquiries as to the probable cost of establishing new weights and measures in each of 11 of the leading trades. The average cost to the retail trader, using nine weights and 11 measures, would be £1. 8s. 6d., or about £80,000 for London. A reasonable period should be allowed before the new system came into use, and a further period before it was made compulsory. If school children were more thoroughly taught the metric system it would be a great assistance to any change. The Council was of opinion that the prohibition of the use of metric weights and measures for the foreign trade was unnecessary.

Telegraphic Communication under Difficulties. A contributor, writing to the *Indian Engineer* in regard to the Gilgit telegraph, says the winter in Kashmir has been an exceptionally severe one. A correspondent writing him from Srinagar on February 20, said it had been snowing steadily for 72 hours. The snow lay 3ft. deep in Srinagar, and at Baramula it was 6½ft. Before this snow-storm began, there was a regular hurricane for four days in the Gurais Valley, and the air was darkened with the whirling snow blown up. Notwithstanding this severe trial, the telegraph line to Gilgit continued to work without a breakdown, and the problem of keeping up reliable communication with that distant and important agency appears to have been successfully solved. The cold has been intense. Great floes of ice are floating down the Jhelum, which is very nearly frozen over. The Woolar Lake is completely frozen, and there has been skating on the Dâl, near the Nasim Bagh. How the telegraph staff isolated at Garais and Minimarg have been able to get on is a wonder; their experiences when the passes are open, and they are able to look once more upon the faces of their fellow men, should be interesting.

Electric Motors on War Vessels.—It is stated that the French claim to be the first to apply electricity to turret guns. A daily paper, however, states that in the matter of electric motors the English Admiralty have taken the lead. When the "Centurion" was fitted at Portsmouth it was intended, on the initiative of Sir Joseph Whitworth and Co., to apply an electric installation in the two barbettes, but as the plant and gear could not be supplied in time, and the vessel was wanted for China, the gunnery trials were prosecuted at Spithead about a year or so ago, under the ordinary conditions. Since then, however, in March last year, electric motors were experimentally applied to the 10in. guns in the turrets of the sister ship "Barfleur," and with such success that the battleship was enabled to make use of the innovation throughout the naval manœuvres. After returning to Chatham the same firm introduced some modifications in the installation with a view of simplifying the mechanism and giving the guns the full protection of the redoubt armour. The new arrangements were recently tested and proved thoroughly satisfactory, the fine sighting of the guns at all angles being under complete control.

Telephone Cables in Sewers.—It was mentioned at a recent meeting of the City Commission of Sewers that some doubt existed as to the right or legality of the Commission to accept payment from the City of London Electric Light Company in return for the latter being permitted to use the tubes already laid in the ground for the accommodation of telephone circuits. A somewhat similar case is reported from Paris, the dispute being between the State and the town of Paris. The second article of the Telegraph and Telephone Act of 1885 states that "telegraphic or telephonic wires other than those lines of general interest can only be placed in sewers belonging to communes after notice to the municipal councils and by paying a tax if required to do so by these councils." When the French Government took over the telephones in 1890, the town of Paris contended that it also transferred the liabilities of the company to the State, and a continuation of the payment of the taxes which the company paid until the transfer was made was demanded. The Minister of Commerce affirmed that the working of the Paris telephones by the State had terminated a commercial speculation and that the lines were of public interest. The matter was then taken by the town to the Conseil d'Etat who have now rejected the appeal of the town.

Wire Fence Telephones.—In a communication to the *Scientific American*, Mr. E. Aeggle, of Gunbower Station, Gunbower, Victoria, states that some two years ago he utilised the top wire of the existing fences on that station for telephonic purposes. Since his station was satisfactorily served by this inexpensive method (2s. 6d. per mile) of telephoning, he has received many letters asking particulars from all parts of Australia. At the present time there are many hundreds of miles of station fences throughout that and the neighbouring colonies brought into requisition for the purpose. The climate is very dry (average rainfall 8in. to 9in.) and in consequence insulation is not such an important matter. On that property at Gunbower there are about 600 posts to the mile of fencing, the wire passing through an augur pole in the ordinary way; the rust that forms on the wire makes a sufficiently thick skin to insulate it from slight moisture. At the straining posts the rust is filed off the wire at either side, and a piece of clean wire to carry the current round the post is tightly screwed on; at knots or loop joints a continuous connection in the same way is made. The ordinary long distance microphone transmitters are used at either end, with call-

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bells and receivers. In addition, a portable instrument, which can be attached to the wire at any point when out on the run, is provided, and in this way messages can be sent to the homestead. The longest service is 16 miles, but one run has a continuous service of 28 miles, and from his experience there is no reason why in a dry climate it could not be utilised on much longer lengths.

Chemical Properties of Argon.—The *Times* states that M. Berthelot, the distinguished French chemist, and secretary of the Academy of Sciences, supplies the first bit of solid information concerning the chemical properties of argon. In experimenting with a small quantity of that substance furnished by Prof. Ramsay, he has found that under the influence of the silent electric discharge it combines with various organic compounds, and notably with benzene. It is decidedly interesting to discover that argon, which is supposed to be totally inert, and has been vainly subjected to all the most potent agencies at the command of the chemist, is all the time capable of forming a variety of combinations under conditions which always exist in the atmosphere. Great interest also attaches to M. Berthelot's communication in connection with the obscurity which hangs over the chemical nature and relationships of the new substance. For he pointed out years ago that nitrogen combines, under the influence of the silent discharge, with hydrocarbons like benzine, with carbohydrates such as go to build up the tissues of plants, and even with tertiary products such as ether. A bit of moist filter paper, for example, exposed to the silent discharge in presence of nitrogen, whether alone or mixed with oxygen, absorbs a considerable amount, producing a nitrogenised compound which, on heating with soda-lime, gives off abundance of ammonia. As argon seems to be absorbed in the same way, it would be very interesting to learn whether its compound also yields ammonia on heating, or if not ammonia, then what? M. Berthelot promises further details.

National Telephone Company. — The second annual dinner of the staff of the National Telephone Company took place on Friday evening at the Holborn Restaurant. In the absence, through illness, of Mr. James Staats Forbes, the chairman, the chair was taken by Mr. W. E. L. Gaine, the general manager. The company included Lord Kelvin, Lord Balfour of Burleigh, Sir Albert Rollit, M.P., Sir Robert Hunter, Mr. Dane Sinclair, Prof. D. E. Hughes, and Mr. W. A. Smith. After the loyal toasts the chairman sent a telephonic message to Mr. Forbes, who telephoned a reply. The chairman proposed "The National Telephone Company," commenting upon the progress which the telephone had made in a comparatively short period. In reply, Lord Balfour of Burleigh, vice-president, said that this was an age of experiments. The Post Office had recently completed a trunk communication between Scotland and the south as far as Birmingham. He hoped that before long it would be found possible to work a telephone commercially between London and the north. Lord Kelvin, responding for "Telephony," said that in 1876, when the telephone was first brought to this country, the general public looked upon it as a wild dream of the scientific imagination. Very soon it became a great working reality, and now, as they had heard, it had been extended to communication between Mid-England and Scotland. The toast in honour of the Post Office was coupled with the name of Sir Robert Hunter, who spoke of the cordial relations between that department and the company. That of "Our Guests," was replied to by Prof. Hughes, whose remarks are given in another column.

Polarisation.—In discussing this subject in the *Zeit. Physikal. Chem.*, Mr. J. Roszkowski states that he employed for the polarising E.M.F. a Gülcher thermopile of 50 elements capable of yielding a pressure up to 3·5 volts, a Leclanché cell and four standard Clark cells being employed for its determination. The cathode examined was immersed in an N/10 solution of sulphuric acid, and the polarisation determined by the measurement of the E.M.F. obtained from this cathode connected with a calomel element—that is, practically, the chain, cathode, N/10 sulphuric acid, potassium chloride solution, mercury. Experiments on the effect of the duration of the current were made with cathodes of polished and platinised platinum, polished silver and mercury, and the polarisation reached its maximum constant value in from two to three minutes (polished platinum 15 minutes). The effect of the current strength on the polarisation was obtained by the addition of external resistances. With a platinised platinum cathode of two square centimetres area and an E.M.F. of 3·3 volts, the polarisation decreased to a minimum of – 180 volts when 700 ohms had been added, further addition having no effect. A similar decrease was obtained by the addition of internal resistance—that is, substitution of Leclanché cells for the thermopile. The influence of the size of the cathode was investigated by the use of mercury electrodes of respectively one and two square centimetres, and although for low E.M.F.'s the smaller cathode gave markedly greater polarisation, at 3·3 volts the values were almost identical. The nature of the surface was then altered and platinum electrodes (1) polished, (2) platinised, (3) platinised and heated to redness, (4) covered with scratches, were employed. Very different values for the polarisation were obtained, the highest values being obtained with (4) and lowest with (2). The platinised cathode also gave the curve of polarisation, polarising E.M.F., approximately a straight line of inclination $\tan^{-1}\frac{1}{3}$. In no case does a maximum value occur, and the differences the author considers to be due to different occluding powers of the surfaces. Similar experiments were performed with silver cathodes with entirely similar results, the differences between the differently prepared silver cathodes being, however, not as great as with the platinum electrodes.

Economy in Coal Consumption.—The National Electric Light Association Committee on Data presented a tabulated statement at the meeting recently held at Cleveland. The table contained reports from 24 stations using coal as fuel. The highest economy is shown in one case where 262 watts are generated from 1lb. of coal, the plant furnishing nearly 23,000,000 watts during 24 hours, the equipment being triple-expansion engines with dynamo on the engine shaft, and horizontal water-tube boilers with heaters, without economisers, the firing being done by hand. This result is secured from one-half each soft coal and hard screenings. An examination of this report proves it to be a high average for 24 hours, as with an evaporation of 9·37lb. of water per pound of combustible, and a water consumption of 17lb. per horse-power, allowing 10 per cent. non-combustible in the coal, and taking the efficiency of the generators as stated at 85 per cent., we have $\frac{9\cdot37\times\cdot90}{17}\times746\times\cdot85=314$ watts produced from 1lb. of coal. This average is much nearer the theoretical efficiency of a modern steam plant than any report previously received by this committee. Taking an average of the 10 reports from stations generating over 5,000,000 watts in 24 hours, we have 147·5 watts per pound of coal, or a production of 1 e.h.p. for 4lb. of coal on a basis of the efficiency of the generating machinery as stated in the last report by this committee. Previous reports by this committee have been criticised as inaccurate and incomplete, and an attempt has been made

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in the statement submitted to improve it in both these particulars. From the first the results of this work have been handicapped by reports from the central stations incorrect, incomplete, and based upon a variety of testing instruments constructed without any absolutely uniform standard. And, again, many central-station managers do not wish to have their work made public, and in order to get at the results secured by these people, the information has previously been furnished to the committee, through the secretary, in such a manner that the committee were relieved of the responsibility of the exact source of the information furnished. This in a measure defeats the main object of the work. A careful review of this work for the past three years reassures this committee that the present method of securing data from central stations by individual effort on the part of the committeemen, with the understanding that the information is to be held confidential, meets all the requirements, as any manager can communicate with the author of any report either through the committee or the secretary of this association.

Traction in New Zealand.—It is now some time since we referred to the proposal of the Dunedin City and Suburban Tramways Company, to substitute electric for horse traction. The report of the directors which, according to the *New Zealand Journal of Insurance*, was adopted at a meeting of the company held in January stated that "The protracted negotiations which have been proceeding with the view of introducing electricity as a motive power, have resulted in the Government agreeing to bear the cost of the necessary alterations to the telephone system, and during the last session of Parliament a Tramways Bill was passed enabling the Government to grant powers to tramway companies to use electricity. The directors hope shortly to obtain the Orders-in-Council, the details of which are now in course of being settled. The haulage contract expired in December last, and seeing the difficulties in the way of the proposed change of haulage, the directors deemed it advisable to enter into a new contract for a term of three years. The company have, however, the option of terminating the contract at an earlier date." In regard to this Mr. G. Fenwick (the chairman of the company) stated at the meeting in question that it was two years and eight months since the first offer was made to the company to change the system, and that it was over two years since the agreement was actually entered into with the Dunedin syndicate, who took up the matter energetically and carried on negotiations almost to a successful point. But they were blocked by the fact that the law of the colony at the time did not give power for the use of electric traction. The directors set themselves to work to get over that difficulty, and it seemed a strange thing, but it was nevertheless true, that they had been driven to all sorts of means, including personal interviews with Ministers of the Crown, evidence before a Parliamentary Committee, and endless correspondence by letter and telegram, to accomplish this end, and it was only on October 23rd last that they succeeded in getting the necessary Bill through the Legislature. The Bill was passed in the very last week of the Session. But they still required an Order-in-Council before the company could give a clear title to a purchaser. He was glad, however, to be able to say that the details of the Order-in-Council were now practically settled. He could not definitely promise that this would be concluded by a certain day, but virtually the thing was settled. Meantime, as to the arrangements which had been entered into by the syndicate with the capitalists they were dealing with at Home, they did not look too promising. They might possibly fall through. He could not say whether this would be so or not. Capitalists in England did not care to keep their money locked up for nearly three years, and doubts had arisen as to whether all these negotiations would not have to be started afresh. He could not say for certain. The shareholders, however, might rest satisfied that the directors would do their best to bring about this long desired change in the haulage arrangements.

Storage of Energy in Central Stations.—A very lengthy paper on "The Storage of Energy Essential to Economy of Working in Central Stations" was presented by Mr. N. W. Perry at the recent meeting at Cleveland of the National Electric Light Association. The author stated that when we consider how enormously short the results of actual practice in lighting stations are of those which are obtainable under the most favourable conditions with the same machinery, it behoves us to enquire into the cause of this deficiency and to see how far we can remedy it. Prof. Kennedy had made some very careful tests to indicate the effect of variable load upon coal consumption. Dividing the day into three portions, he determined the fuel consumption, the feed water evaporated, and the indicated and electric horse-power developed during each period in an English lighting station. During the periods of light load the fuel consumption per horse-power is very large. Captain Sankey had applied Mr. Willans's formula to find the steam consumption of one or more engines working against a variable load in an electric lighting station. He takes a normal midwinter load curve and examines how the necessary current could be supplied during the 24 hours (1) with an engine capable of exerting the maximum power required, (2) with smaller engines. The results, rearranged and a little modified, are given by Prof. Unwin, it being assumed for convenience that the maximum load is 500 e.h.p. and that the engines are non-condensing. These results closely agreed with Prof. Kennedy's figures, derived from direct tests which gave 24 per cent. increased consumption at mean load over that at maximum load. Having shown by Prof. Unwin's figures that with engines working on a very regular load the total annual cost per electrical horse-power is less than half of that with engines running with a variable load under conditions similar to those of a central station, the author discussed the annual cost per horse-power with various systems of storage. The following table gives the results obtained by the author. The table shows the cost to produce for one year 1 e.h.p., with coal at \$1·75 per ton and at \$3·50 per ton; also, the saving effected by the various methods over present methods in a station having a mean load 25 per cent. of its maximum:

	Annual cost of 1 e.h.p. Coal \$1·75 per ton.	Annual cost of 1 e.h.p. Coal \$3·50.	Saving effected. Coal \$1·75.	Saving effected. Coal \$3·50.
Present method, steady load	\$48·68	\$65·62	—	—
,, gas-engine	88·28	103·61	\$29·50	\$44·79
Combined feed and steam storage	94·42	111·35	23·36	37·05
Feed storage	97·58	117·58	20·20	30·82
Without storage, load factor 25%	117·78	148·40	—	—
Steam storage	117·84	134·77	− 00·06	+ 13·63
Complete battery storage	123·13	145·74	− 5·35	+ 2·66

The author concludes that of all the methods of storage available the storage battery would, on theoretical grounds, be the best, because of its forming the last link in the chain, thereby giving the economies of continuous working to all that precede. Unfortunately, it involved such large losses in itself as to nearly, if not quite, nullify the advantages it would otherwise present. And, again, its extreme cost above all other methods renders it unavailable in any complete storage project, unless fuel is dear. We are therefore compelled, he states, to go back of the engine for our equalisation schemes and put up with the losses due to variable load upon all that follows.

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THE EARLY HISTORY OF TELEPHONY.

We reproduce below the text of the reply of Prof. D. E. Hughes, F.R.S., to the toast of "Our Guests" at the banquet given by the staff of the National Telephone Company on the 15th inst.:

I am exceedingly grateful to you for having so kindly mentioned my name in connection with the toast of your guests, and I am sure that I am only expressing the sentiments of all your guests in thanking you for having so kindly invited us to participate in this magnificent banquet on such an important occasion.

To me this is indeed an important event in the history of telephony, for I see around me some 200 members of the staff of the National Telephone Company, which now represents one of the most useful and powerful commercial organisations of the present age. When I look back only some 40 years to the first printed idea in France, and some 30 years to the birth in Germany of its first telephone, and that it is only 18 years since the idea became really practicable, I am indeed astonished at its wide-spread success, so that what was a few years since a scientific toy, now has become a necessity of our present age.

The earliest record of a perfect theoretical electric telephone was contained in Du Moncel's "Exposée des Applications," Paris, 1854; when M. Charles Bourseul, a French telegraphist, conceived a plan of conveying sounds and speech by electricity. Suppose, he explained, "that a man speaks near a movable disc sufficiently flexible to lose none of the vibrations of the voice, that this disc alternately makes and breaks the current from a battery; you may have at a distance another disc which will simultaneously execute the same vibrations." Unfortunately M. Bourseul did not work out his idea to a practical end, but in these few words we have the shortest possible explanation of the theory of our present telephones.

It is now exactly 30 years since my first experiments with a working telephone, for in 1865, being at St. Petersburg in order to fulfil my contract with the Russian Government for the establishment of my printing telegraph instrument upon all their important lines, I was invited by his Majesty the Emperor Alexandre II., to give a lecture before his Majesty, the Empress, and Court at Czarskoi Zelo, which I did, but as I wished to present to his Majesty not only my own telegraph instrument, but all the latest novelties, Prof. Philipp Reis, of Friedericksdorf, Frankfort-on-Maine, sent to Russia his new telephone, with which I was enabled to transmit and receive perfectly all musical sounds, and also a few spoken words, though these were rather uncertain, for at moments a word could be clearly heard, and then from some unexplained cause no words were possible. This wonderful instrument was based upon the true theory of telephony, and it contained all the necessary organs to make it a practicable success. Its unfortunate inventor died in 1874, almost unknown, poor, and neglected, but the German Government have since tried to make reparation by acknowledging his claims as the first inventor and erecting a monument to his memory in the cemetery at Friedericksdorf.*

The duties connected with my printing telegraph instrument prevented me from continuing my experiments with the telephone of Prof. Reis; but in 1876 we heard in Europe of the invention by Prof. Alexander Graham Bell of his wonderful telephone, by means of which the practical transmission and reception of human speech had become an accomplished fact, and early in 1877 the instrument was brought to England. I at once resumed my experiments of 1865 with it, and found that Prof. Bell's telephone, considered as a receiver, was absolute perfection, but that his mode of transmission of magneto-electric currents, generated solely by the movement of an iron diaphragm near its electromagnet, was defective, as the currents produced were too feeble for any practical use. I then tried to adopt Prof. Reis's system of using a separate battery, brought into play by the movement of a diaphragm.

I will not cite the numerous experiments and difficulties that I met with in this research; but at last I succeeded in finding the effect I wished, by the use of a very slight electric contact of the surface of solid carbon, or any other metals, such as ordinary iron nails. This slight or microphonic contact has the remarkable power of varying the resistance, and, consequently, the force of an electric current, exactly in accordance with the sonorous vibrations of the human voice; and, in fact, the contacts could easily be rendered so sensitive that the instrument became a true microphone, rendering audible sounds far too feeble for the human ear. All of these results I gave freely to the public, and brought before the notice of the scientific world in a paper I read to the Royal Society in May, 1878.

Another discovery which I made in the continuance of my researches, which is now of the highest utility to far-distant telephony, was the use of twisted wires, or wires so arranged upon their insulators that the whole line should gradually revolve on its axis, so as to prevent induction from other independent wires. This was given freely to the world in my paper read before the Society of Telegraph Engineers, March 12, 1879, and fully illustrated by engravings in *Engineering* of the same week. In order to understand this, I will quote a single paragraph from this paper.

"If two ordinary aërial lines are thus used, they should have the twist given to these wires by changing their position relatively to other wires from vertical to horizontal at each pole or mile. Thus, if we had two lines, A and B, they should have their four relative positions repeated as often as possible—viz., A B, then $\frac{B}{A}$; then B A and $\frac{A}{B}$."

This is the system employed by the telephone line between London and Paris, and, in fact, upon all successful long-distance telephone lines throughout the world, so I think it is only fair that it should be known that I discovered and published this long before long-distance telephony was ever brought into use.

During the same months of 1877 that I was experimenting with Prof. Bell's telephone, Mr. Edison in the United States was also engaged upon a similar research—viz., endeavouring to adopt Prof. Reis's method of transmission by a diaphragm and separate battery, and he succeeded in inventing and patenting his form of transmitter, which he called the carbon telephone. This transmitter was brought to England in 1878, and it worked remarkably well, although I felt convinced then, as I am still, that the theory upon which it was supposed to work was wrong. Mr. Edison's views were that its mode of action was based upon the varying resistance obtained through a varying pressure of the diaphragm upon an elastic button of carbon. (He believed that the varying resistance of carbon by pressure was an original discovery, but it was well known for many years previous in Europe through its publication by Du Moncel, and its application by Clerac in his carbon resistance tube, whose resistance was varied according to the pressure given to its adjusting screw.) The error of this theory is shown by the fact that we cannot obtain more than a difference of resistance through pressure upon any conducting substance but of a few ohms, say one to ten, but with a microphonic joint we can easily obtain the widest possible range, from almost zero to an infinity of resistance, and this with the smallest possible expenditure of mechanical energy from the diaphragm, or even without a diaphragm. I believed then, as I do still, that its excellent functions were due to a microphonic joint, of which, and of the value of which, he was unaware, and I also believe that the often successful transmission of words by Prof. Reis's transmitter was due to an accidental adjustment of his contacts to a true microphonic condition. He was, of course, unaware of the power and importance of microphonic joints, else his telephone would have been a practical success at once.

Unfortunately, Mr. Edison and myself had a painful discussion as to priority of invention, in which we have both sustained our individual views up to the present time. Mr. Edison's views have been sustained by all the companies owning his patent; mine have been sustained by nearly the whole scientific world. The companies, however, whose interest it was to sustain and possess for themselves an

* "Philipp Reis, Inventor of the Telephone." A biographical sketch by Prof. Sylvanus P. Thompson, F.R.S., etc., London. E. and F. Spon, 1883.

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entire monopoly, have spared neither wealth nor power to obtain this coveted monopoly, and by the means of the ablest legal counsel and expert witnesses they obtained a legal decision giving them the sole right to the use of a diaphragm pressing upon a variable resistance, notwithstanding that the diaphragm was the discovery of Prof. Reis and microphonic contact by myself.

This is all now past history, but I am now more than consoled by the fact that at the present time there is not a single transmitter in practical use throughout the world whose function is not based entirely upon its microphonic joints, whether in the form of solid conductors pressing upon each other, or when these contacts are multiplied as in the form of granules or powder.

In conclusion, it gives me great pleasure to call attention to the vast progress and improvement in the telephonic system, due to the energy and enterprise of the different telephone companies. The telephone and microphone would have never reached its present vast stage of usefulness if it had not been for the establishment of the exchange system, with its complex and costly system of switchboards. This has enabled a single subscriber upon any separate line to be brought into almost instantaneous connection with any chosen subscriber out of thousands on the list. They have built the best possible of lines, and whenever possible have given a complete metallic circuit in order to avoid induction from other lines.

I beg to thank you for having so kindly listened to my few remarks, and to thank you most sincerely, in the name of your guests and myself, for the warm hospitality with which you have welcomed us here this evening.

ELECTRIC CURRENTS OF HIGH PRESSURE AND PERIODICITY.*

BY A. A. C. SWINTON.

The experimental effects that I propose to show this afternoon are all produced by utilising the disruptive discharges of Leyden jars to give electrical impulses of comparatively considerable magnitude as regards energy, but of exceedingly short duration as regards time.

As is well known, if a Leyden jar be discharged through a stout copper wire forming a circuit of small resistance, a surging of the electrical charge is set up, with the result that the electric current which passes through the wire is of the nature of a gradually dying-away oscillation. The action may, indeed, be compared to what occurs when a pendulum, immersed in some viscous fluid, is suddenly released from an inclined position and swings backwards and forwards with a gradually decreasing amplitude of oscillation until it comes to rest; or we may make the analogy more exact by comparing the effect to a loaded spring bent aside in a resisting medium and then let go. The pliability of the spring corresponds to the capacity of the condenser, its displacement to the electrical charge, the load or inertia to the self-induction of the circuit, and the viscosity of the fluid to the resistance of the circuit.

Thus the total duration of the discharge of a Leyden jar varies with its electrostatic capacity, being longer for large jars than for small. At the same time, both the duration of the discharge and the rate of oscillation are dependent upon the resistance and self-induction of the discharging circuit. In apparatus of the kind that we employ the conditions are exceedingly complex, and consequently calculations as to the duration of the discharge, or as to its rate of oscillation, must necessarily be only approximate. The total duration of the discharge itself can, however, be fairly accurately measured experimentally by means of a revolving mirror, and I think you may take it as tolerably correct when I tell you that the total duration of each discharge of the batteries of Leyden jars that we have here, and are going to use, is about $\frac{1}{50000}$ of a second. It has been further calculated that, with the conditions that we are working under, the rate of oscillation should be about 200,000 complete periods per second, so that apparently we get about four complete oscillations in each of our discharges.

* Contribution to the Professional *Papers* of the Corps of Royal Engineers, Chatham.

Our jars are charged by means of an alternate-current dynamo machine, which has a frequency of approximately 100 complete alternations per second. The jars are charged and discharged at each half-period, consequently one in each $\frac{1}{200}$ of a second. The duration of the discharge is, as already mentioned, $\frac{1}{50000}$ of a second, and consequently, if we devote our attention merely to what is taking place in the discharging circuit, there are intervals between each discharge of $\frac{249}{50000}$ of a second, during which intervals there is no current passing at all.

Fig. 1 shows this from a diagrammatic point of view. Only four discharges are shown, and it has unfortunately not been possible to show the intervals between them to scale, as, if shown on the same scale as the discharges, each of which on the diagram occupies 10in., the intervals ought to be no less than 208ft.

It has been usual to call oscillatory currents produced in this manner "high frequency" or "high periodicity electric currents." I am not sure with whom the term originated, but I think it was with Mr. Tesla, to whose investigations in this particular branch of electrical science we all owe so much. I am bound to say, however, that the term seems to me to be a very unfortunate one, as, though the periodicity is decidedly high during each discharge, the discharges are of so very short duration, and are spaced by such comparatively long intervals, that the average frequency is really not high at all; in fact, in the experiments I am about to show you, the average frequency appears only to be about 800 a second as against 100 a second, the periodicity of the alternator supplying the original current.

Further—and what I am now going to say is, I believe, in direct contradiction to the orthodox view—it does not appear to me that any high frequency at all is necessary

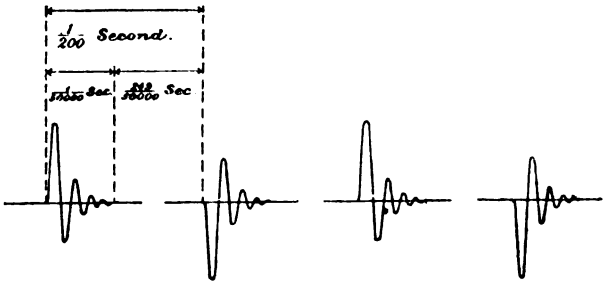

FIG. 1.

to explain the effects produced. All that is necessary is that the electric current should be delivered in impulses of exceedingly short duration, in which the current and voltage rise from zero to enormously high maxima, and fall again to zero with exceeding suddenness. The defects are, in fact, due to the rapid rate of change.

Now, oscillatory or pulsatory currents of the description that I have mentioned behave in many respects in quite a different manner from continuous or ordinary alternating currents. This is due to the fact that while with ordinary alternating currents the effects of impedence, induction, and electrostatic capacity are comparatively small, unless we take special means to render them operative, with our oscillatory currents these effects are comparatively enormous, and show themselves whether we will or no.

To take first of all the case of impedence. We have here a thick copper wire bent into a U-shape, which would conduct an ordinary alternating current with practically no impedence at all. We have it connected, as shown in Fig. 2. We start with a 100-volt alternating current of the ordinary description, which passes through the primary of an induction coil. From the secondary of this coil we obtain some 20,000 to 30,000 volts, This high pressure current charges the Leyden jars at each half-period up to a point where the air resistance across the spark gap is broken down, and a disruptive oscillatory discharge takes place. In this manner we obtain an oscillatory discharge of electricity through our U-shaped piece of copper wire. In order to let you see the effect of the impedence, I will connect these incandescent lamps across from one leg to the other of the U-shaped wire. You will observe that though short-circuited by the wire, which has enormously less ohmic resistance than the lamp filaments, the latter

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incandesce brightly. The oscillatory current, in fact, does not take the path of least ohmic resistance, as might be expected, but the shortest path—*i.e.*, that of least self-induction and impedence. By sliding the lamps up and down we can make them burn more or less brightly, and by choosing suitable positions we can make lamps varying in voltage from 20 to 100 volts all burn with uniform brightness.

Again, oscillatory electric currents such as those with which we are dealing, have much more powerful inductive effects than ordinary alternating currents.

We have here two circles, each consisting of a single convolution of thick copper wire. One of these circles has a 20-volt 5-c.p. incandescent lamp connected to the two ends of the wire, and the other circle is connected as was the U-shaped wire in the last experiment, so that we can send oscillatory discharges through it. We will hold the two circles facing one another about 6ft. apart and turn on the current. As you see, the lamp filament is gradually becoming red hot, showing that the oscillatory current passing through the one circle is inducing an electric current in the other. If we bring the circles nearer together the light becomes brighter, and with an interval of 2ft. the lamp is fully incandesced.

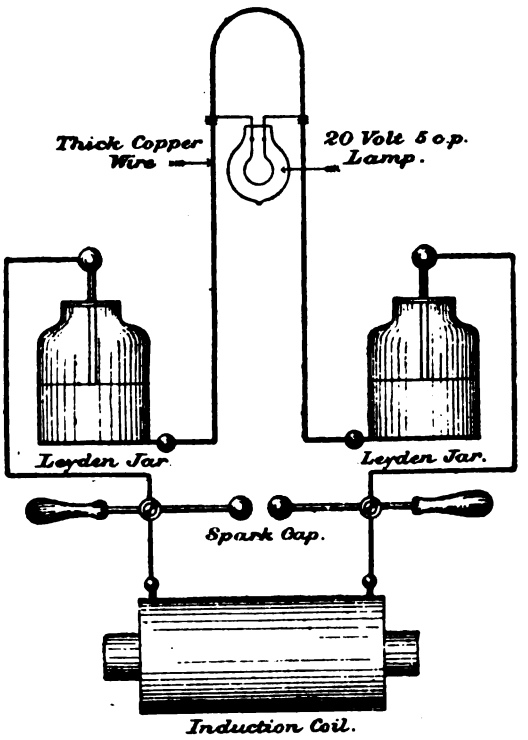

FIG. 2.

One of the most striking facts in connection with these oscillatory currents is the small physiological effect that they appear to have on the human frame. As is well known, the discharge of a good-sized Leyden jar, if taken direct, occasions a most violent shock to the system, and may, indeed, be sufficient to destroy consciousness for a time, or even to cause death. The current from a medical magneto machine, or even a small induction coil, is sufficiently unpleasant for most people, while that from an alternate current dynamo giving 1,000 to 2,000 volts is used for official electrocution in the United States of America, and has been the cause of more than one death in this country. The electric currents employed in medicine rarely exceed a few thousandths of an ampere, muscular fixation and other unpleasant results being usually produced when more than 10 to 20 milliamperes of continuous, or two to six milliamperes of alternating or interrupted, current is passed through the body.

We have here an ordinary 5-c.p. 100-volt lamp, which, with continuous or ordinary alternating current, requires about one-fifth of an ampere or 200 milliamperes to bring it to full incandescence. This is, of course, a much greater strength of ordinary current than anyone could bear for a moment. We will incandesce this lamp with current conveyed through the bodies of two persons. The connections are as shown in Fig. 3, and, as you will observe, there is no connection between the lamp and the other apparatus except through the arms and bodies of the two operators. As you will see, the lamp filament is brought up to full incandescence when we turn on the current.

Various theories have been propounded to account for the harmlessness of these currents. Some have supposed that the human body acts not as a conductor, but like a condenser with regard to the passage of alternate currents, forgetting that were this the case the impedence offered to oscillatory currents would be very small, and the application of high voltages, such as I have been using, would consequently be serious. Some, on the other hand, have imagined that it is all a question of the nerves, which they assume to be, as it were, tuned only to respond to alternations of comparatively low periodicity, and being unaffected by those above a certain range, as is the eye to luminous waves above the frequency of violet light.

The real facts of the case seem to be that wherever these oscillatory currents are harmless, it is simply for the reason that the quantity of electricity they transmit in any given time is too small to do any injury. Leaving on one side

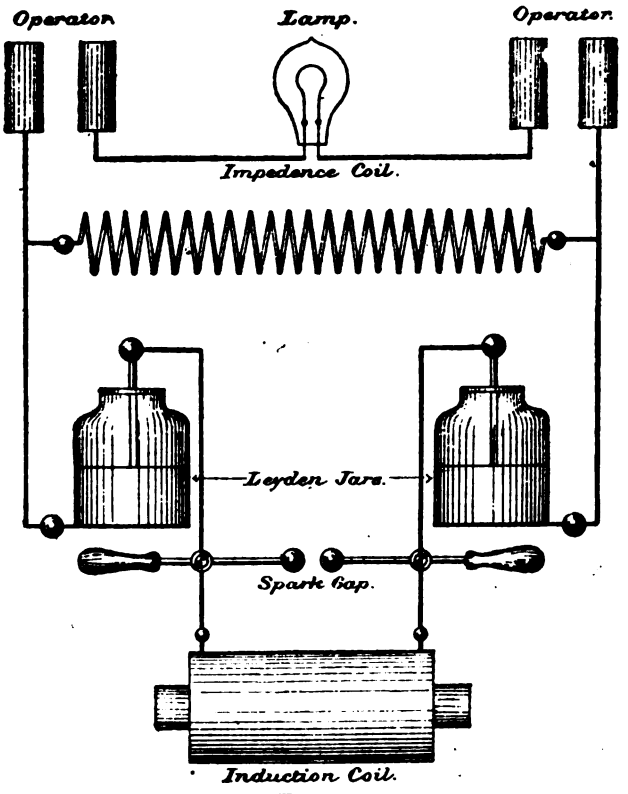

FIG. 3.

those physiological effects which from the burning and disruptive action produced in the tissues traversed are clearly due to the internal production of considerable quantities of heat, the physiological effects of electric currents seem most probably to be due to chemical decomposition—in fact, to electrolysis. Now the amount of electrolytic effect in any given time, is of course, proportional to the quantity of electricity—that is to say, to the number of the coulombs passed in that time. What, therefore, can be more natural than that the physiological effects of electric currents should, within limits, be proportional to the coulombs of electricity passed.

It will, however, be said that in the lamp experiment I have just shown you the current in the lamp must have been one-fifth of an ampere, and that, consequently, whatever the description of the electric current—continuous, alternating, or oscillatory—one-fifth of a coulomb was passed through the arms and bodies of the operators during each second that the lamp was lighted.

A little consideration will, however, show that this is by no means the case. In the first place, as has been shown by Lord Kelvin, oscillatory currents which rise and fall between minimum and maximum very rapidly do not flow uniformly through the section of a conductor. They tend to keep on the surface, and given sufficiently sudden

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fluctuations, may only be, as it were, skin deep. Applying this to the filament of our lamp the effect is to increase its resistance, since only a part of the section of the filament acts as a conductor. The filament might, in fact, be a hollow tube instead of a solid wire. We have ample sufficiency of available voltage, and though the strength of the current may be small, the resistance being high there is a sufficient expenditure of watts to raise the filament to incandescence. The lamp, in fact, ceases to be a 100-volt lamp taking one-fifth of an ampere, and becomes, may be, a 1,000-volt or even a 10,000-volt lamp, taking only a tenth or a hundredth of that amount of current.

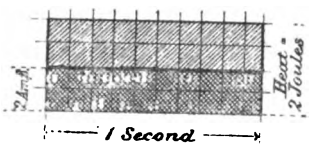

FIG. 4.

Steady Current.—Assumed resistance = 1 ohm; assumed quantity, 2 coulombs; time = 1 second; ∴ current = 2 amperes; ∴ heat generated = 2 joules.

There is also another point to be borne in mind. The current is delivered in impulses of exceedingly short duration. If we turn to Fig. 4, the double-cross shaded portion of the figure represents a current of two amperes flowing for one second of time. The area of this portion thus represents two coulombs of electricity. If we assume that this current is being passed through a resistance of one ohm, the heat generated in the resistance will clearly be equal to two joules. So much for continuous current. If we now turn to Fig. 5, we have a similar quantity of electricity—namely, two coulombs—passed through a similar resistance of one ohm; but instead of sending the current through continuously for one second, we will suppose it to be sent through in four pulsations, each lasting for one-tenth of a

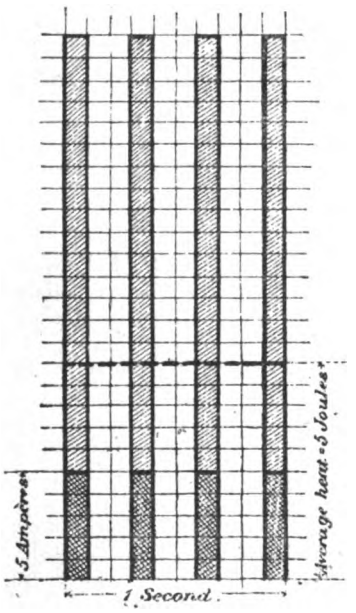

FIG. 5.

Pulsating Current.—Assumed resistance = 1 ohm; assumed quantity = 2 coulombs; total time = 1 second; duration of each pulsation, one-tenth second; then average current during each pulsation = 5 amps, and heat generated = 5 joules.

second, with intervening spaces of one-fifth of a second of no current at all. In order to pass our two coulombs within the second under these conditions, the average current during each pulsation will have to flow at the rate of five amperes, and the amount of heat generated, being proportionate to the square of the current, will be one and a quarter joules for each pulsation. The total heat generated during the second will, therefore, be equal to five joules, as against the two joules generated when we employed a steady current. Conversely, of course, the same quantity of heat can be generated in a given resistance and in any given time with a pulsating current with a less quantity of electricity than will generate this quantity of heat in the same time with a steady current. Further, the shorter the duration of the impulses the smaller is the quantity of electricity necessary, so that when we come to impulses of such exceedingly short duration as $\frac{1}{50000}$ of a second, such as we have been using in our experiments, the quantity of electricity necessary to produce the amount of heat required to incandesce our 5-c.p. lamp must be exceedingly small indeed.

So far we have been dealing with what I may term "primary oscillatory currents"—namely, currents that are derived directly from the Leyden jars without transformation. We will now try the effect of a step-up transformer which is contained in this box, and is entirely immersed in resin oil, in order to prevent sparking and the dissipation of energy by leakage either in the shape of conduction or brush discharges. The arrangement of the connections may be as shown in Fig. 6.

We are now dealing with oscillatory discharges having a potential difference that may be measured in hundreds of thousands of volts, and, as you will notice when the light is put out, the brush discharge effects are very striking. If I present my hand to one of the terminals of the coil sparks shoot out to my fingers. These sparks cause a painful pricking, but if I take a piece of metal in my hand and present it to the terminal I can take a violent discharge of sparks practically without any sensation. If I take hold of one terminal of the coil with one hand, which I can do without hurt, and present the other hand to the outside of the box of oil containing the coil, streams of sparks issue from my finger tips. Again, having hold of one terminal I can draw sparks from any body having electrostatic capacity, such as another person or any metallic body, merely by bringing my free hand, or for that matter my foot or any part of my body, near to them.

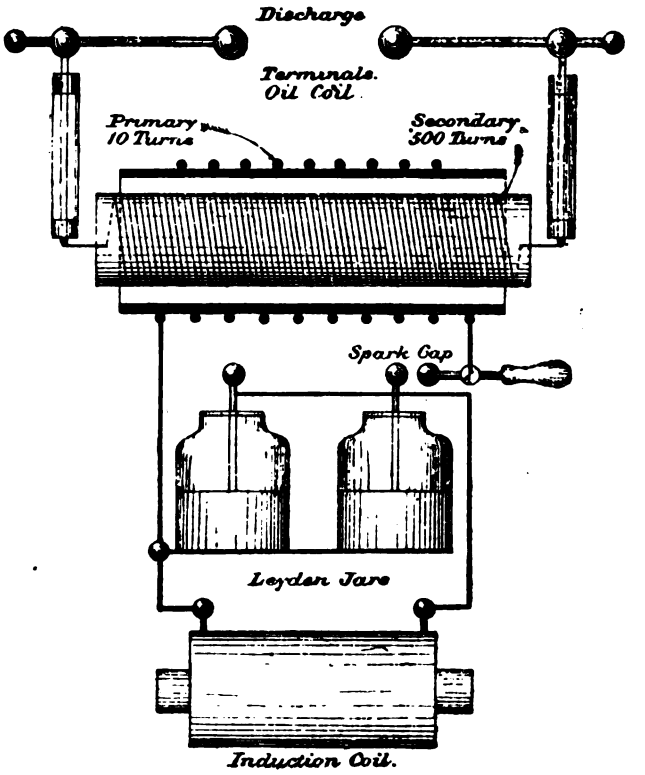

FIG. 6.

The high-tension oscillations have also marked electrostatic inductive effects. We will show this by attaching a tin-plate to each of the two terminals of the coil. We have here two other tin-plates, between which an incandescent lamp is connected. When we bring these latter plates within a foot or 6in. of the others, the lamp incandesces brightly. We can also incandesce a lamp filament by connecting one lamp terminal to one coil terminal and merely touching the other lamp terminal with a piece of metal held in the hand. The operator can stand upon an insulated stool, it makes no difference, as the effect is due not to any circuit being established, but to the electrostatic capacity of the operator's body. The electricity in fact merely runs in and out of the operator through the lamp, and thereby incandesces the latter.

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Pretty effects can be shown by passing the high-tension discharge through a piece of wood, the sparks finding their way through the substance of the material and lighting it up with a dark red colour. Or a piece of glass, one side of which is covered with tinfoil, may be placed between points connected to the terminals of the coil. As will be seen, the discharge spreads out in fiery streamers over the glass with a loud roar. By substituting a dry photographic plate for the glass we can obtain photographs of the discharge taken with its own light. I have had lantern slides made of photographs produced in this manner, and, as you will see, they give very beautiful effects. The figures produced by positive electricity are irregular, somewhat resembling the rivers on maps. Those produced by negative electricity are, on the other hand, beautifully curved, and are like feathers or palm branches. Oscillatory discharges show both positive and negative figures combined.

The oscillatory electrostatic stresses set up in the neighbourhood of the coil will also produce luminosity in vacuum tubes. If I wave the tubes rapidly you will notice the discontinuity of the light, which is due to the intervals of time between the succeeding groups of oscillations. I have here a cylindrical vacuum tube, outside of which is wound a few turns of thin wire in the form of an open spiral. I connect one end of this wire to one terminal of the coil, and you see two luminous spirals twisting in and out of each other. One is the wire, which glows with a dark purple colour; the other is a species of ghost produced by molecular bombardment inside the tube.

The luminosity of wires can, however, be shown on a larger scale. We have here two circles of wire, a large and a small one. We will connect them respectively to the two terminals of the coil, and place them concentrically in one plane. When we switch on the current and lower the gas you will see that both wires glow brightly, while the interval between them is filled with streamers of purple light; or we can connect these two parallel wires which reach to the other end of the lecture hall, and which become luminous throughout their entire length.

These are all the experiments I have to show to you this afternoon. These phenomena may not in themselves have any immediate useful application, but they are in many ways very instructive. In addition, the essence of science is the correlation of facts, and the further we pry into the secrets of nature the more we are likely to achieve useful results.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 283).

(43) *Magnet Cores.*—(*a*) *Material.*—The field cores should preferably be of wrought iron, or of cast steel, in order to economise in magnet wire; for the use of cast iron, on account of its low permeability, would require cores of at least $1\frac{2}{3}$—*i.e.*, almost twice—the cross-section, and therefore a much greater length of wire to obtain the necessary magnetising force. With the smaller wrought-iron cores the leakage would also be less.

In spite of this decided advantage of wrought-iron cores, cast-iron field magnets are very common, since the temptation to use castings instead of forgings is very great. Where weight and bulk are of no consequence, a cast-iron field magnet may prove nearly as economical as one of wrought iron costing considerably more, but the former requires from one-third to one-half times more wire to encircle it than a wrought-iron one of similar magnetic density, in case of circular cross-section, and it is evident that this, by intro ducing additional electrical resistance, will prove a constant source of unnecessary running expense.

As to the use of steel in dynamos, H. F. Parshall, in a paper delivered before the Franklin Institute, states that magnet frames made of cast steel are 25 per cent. cheaper than those of cast iron, but possess the disadvantage of being not as uniform in magnetic qualities as cast iron. He further asserts that good cast steel should not have greater percentages of impurities than ·25 per cent. of carbon, ·6 per cent. of manganese, ·2 per cent. of silicon, ·08 per cent. of phosphorus, and ·05 per cent. of sulphur. The effect of carbon is to lessen the magnetic continuity and to greatly reduce the permeability; carbon, therefore, is the most objectionable impurity, and if possible, should be restricted to smaller amounts than the maximum above quoted. Manganese, in quantities larger than stated, seriously reduces the magnetic susceptibility of the steel, a 12 per cent. mixture having scarcely greater susceptibility than air. Silicon is objectionable through facilitating the formation of blowholes, and from its hardening effect.

E. Schulz, in comparing two dynamos differing only in the material of the field frame and in the magnet winding, finds that the weight of a cast-steel magnet frame is about one-half of that of cast iron, and that the weight of the copper for the magnets, on account of the smaller cross-section and the greater permeability of the cast steel, is reduced to somewhat less than one-half. The price of the frame will accordingly be about $1\frac{1}{4}$ times that of the cast-iron one, but on account of the reduction of the copper weight, the cost of the whole machine will be less for a cast-steel than for a cast-iron frame, the total weight being less than one-half in the former case.

According to Prof. Ewing, the permeability of good cast steel at low magnetic forces is less than that of wrought iron, but the reverse is the case with high forces. In a specially good sample tested by G. Kapp and Prof. Ewing, a magnetic density of 18,000 lines per square centimetre (= 116,000 lines per square inch) was reached with but little more than one-half the magnetising force as is necessary for the same induction in ordinary wrought iron.

(*b*) *Form of Cross-Section.*—The best form of cross-section for a magnet core is undoubtedly that which possesses the smallest circumference for a given area, and this most economical section is the circle. It is, however, often preferable on account of reducing the dimension of the machine perpendicular to the armature shaft, to use cores of other than circular section; in this case either rectangular, elliptical, or oval cores are employed, or several round cores are placed side by side and connected in parallel to each other,

FIG. 105.

magnetically. The latter method, however, is not recommendable for the reason that the magnetising effects of the neighbouring coils partly neutralise each other, because of the currents of equal polarity flowing in opposite lateral directions in the parts of the coils facing each other, as indicated by arrows in Fig. 105. There is consequently a double loss connected with this arrangement, a larger expenditure of copper connected with higher magnet resistance, and decrease of the magnetising effects by mutual influence of the coils.

Besides the forms mentioned, also square cores and hollow magnets of ring section are frequently used.

An idea of the economy of the form of cross-section to be chosen can be formed by means of the following Table LIII., which gives the circumference for unit area of the various forms of cross-sections employed in modern machines, and compares the same with the circumference of the most economical form, the circle. In the case of rectangular and elliptical cores four forms each are considered, the lengths being respectively two, three, four, and eight times the width of the sections. For oval cores three sections are examined, the semicircular end portions being attached to a centre portion formed of one, two, and four adjacent squares respectively. Next come four sections consisting of several round cores in parallel—namely, two, three, four, and eight separate circles. Of hollow cores, finally, five cases are considered, the internal diameter being respectively of one, two, three, four, and eight times the radial thickness of the cross-section.

Hollow magnets are used in some special types, such as shown in Figs. 84, 94, 95, 96, and 100, where large circumferences of the cores are required, but not the total area enclosed by these circumferences, and where the armature or its shaft has to pass through the centre of the magnet.

* From the *Electrical World* (New York).

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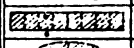
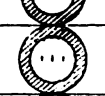
TABLE LIII.—Circumference of Various Forms of Cross-sections of Equal Area.

Form of Cross-Section	Description	Circumference for Unit Area	Relative Circumference (Circle=1)
	Circle	3.545	1
	Square	4.000	1.13
	Rectangle. 1:2	4.243	1.20
	" 1:3	4.62	1.305
	" 1:4	5.00	1.41
	" 1:8	6.364	1.80
	Ellipse. 1:2	3.87	1.09
	" 1:3	4.35	1.23
	" 1:4	4.84	1.37
	" 1:8	6.53	1.84
	Oval. 1 squ. 2 Semi-circles	3.85	1.085
	" 2 " 2 "	4.28	1.21
	" 4 " 2 "	5.09	1.44
	2 Circles	5.01	1.41
	3 "	6.14	1.73
	4 "	7.09	2.00
	8 "	10.03	2.83
	Ring. 1:1	3.85	1.085
	" 1:2	4.09	1.155
	" 1:3	4.43	1.25
	" 1:4	4.76	1.34
	" 1:8	5.91	1.67

As to the use of hollow magnets in place of solid ones, Prof. Grotrian states that with weak magnetising forces only the outer layers of the iron next to the winding are magnetised. E. Schulz, however, showed by practical experiments that the magnetisation is exactly proportional to the area of the core section even at the low induction due to the remanent magnetism. From this can be concluded that Prof. Grotrian's results do not apply to the case of dynamo magnets under practical conditions. A. Föppl claims that the theory of Prof. Grotrian is correct—*i.e.*, that the flux gradually penetrates the magnet from its circumference, and that under certain circumstances it may not reach the centre of the core—but he admits that this theory has no practical bearing upon such magnets as are now used in practical dynamo design.

(*c*) *Ratio of Core Area to Cross-Section of Armature.*—The relation between the cross-section of iron in the magnet cores to that of the armature core is a very important one, as on its proper adjustment depends the attainment of maximum output per pound of wire with minimum of iron.

According to tests made at the Cornell University, under the direction of Prof. Dugald C. Jackson, the best area of cross-section of the magnet cores for drum machines is $1\frac{1}{3}$ times that of least cross-section of armature, if the cores are of good wrought iron, or about $2\frac{1}{2}$ times the minimum armature section if cast-iron cores are used.

According to Table XVII., Chapter 12, the maximum core density in ring armatures is from $1\frac{1}{3}$ to $1\frac{2}{3}$ times that of drum armatures; for equal amounts of active wire, therefore, the former require $1\frac{1}{3}$ to $1\frac{2}{3}$ times as great a magnetic flux as the latter, and the cross-sections of the magnet cross consequently have to be taken correspondingly greater in case of ring machines—namely, $1\frac{3}{4}$ to $2\frac{1}{4}$ times the minimum armature section in case of wrought-iron cores, and three to four times the armature section for cast-iron field magnets.

Prof. S. P. Thompson, in his "Manual on Dynamo-Electric Machinery," gives 1·25 for wrought iron and 2·3 for cast iron as the usual ratio in drum machines, and 1·66 and 3 respectively in ring-armature dynamos.

In the experiments conducted by Prof. Jackson, ten different armatures, all of same length and same external diameter, but of different bores, were used in the same field, thus including a range of from ·5 to 1·4 for the ratio of least armature section to core area. The curves obtained show that the total induction through the armature increased quite rapidly when the armature was increased in area from ·5 of that of the magnets to about ·75 of the core area. From ·75 to ·9 there is still an increase of induction with increase of armature section, though comparatively small, and beyond ·9 the increase is of no practical importance.

(44) *Pole-Pieces*—(*a*) *Material.*—The pole-pieces, if the shape and the construction of the magnet frame permits, should be of wrought iron or cast steel in order to reduce their size, and therefore their magnetic leakage, they being of the highest magnetic potential of any part of the magnetic circuit. In forging, care should be taken that the "grain" or texture of the iron runs in the direction of the lines of force. The pole-pieces, however, usually have to embrace from ·7 to ·8 of the armature surface (compare Chapter 1), and are therefore, particularly in the case of bipolar machines, often comparatively large. If in such a case their cross-section, in order to give sufficient mechanical strength, is to be far in excess of the area needed for the magnetic flux, there is no gain in using wrought iron or cast steel, and the pole-pieces should be made of cast iron. The cast iron used should be as soft and free from impurities as possible. It is preferable, whenever practicable, to have it annealed, and, if not too large in bulk, to have it converted into malleable iron; this is especially to be recommended for small machines.

An admixture of aluminium has been found to increase the permeability of the cast iron; by adding $1\frac{1}{2}$ per cent., by weight, of aluminium, the maximum carrying capacity of the cast iron is increased about 5 per cent., by 3 per cent. admixture it is increased 7 per cent., and by adding 6 per cent. of aluminium the induction increases about 9 per cent.; above 7 per cent. of admixture the permeability decreases, and at 12 per cent. addition of aluminium the gain in magnetic conductivity falls down to 7 per cent. From this it follows that an addition of from 6 to 7 per cent., by weight, of aluminium is the proper admixture for the purpose of improving the magnetic qualities of cast iron, which is explained by the fact that the latter percentage is the limit from which up the hardening influence of the aluminium upon the cast iron becomes appreciable.

In large multipolar machines combination frames, consisting of wrought-iron magnet cores, cast-iron yokes, and cast-steel pole-pieces, give excellent results, having the advantages of the high permeability and uniformity in the magnetic qualities of the wrought iron, of cheapness of the cast iron, and of reduction in size of the cast-steel pole-pieces, and being easier to machine, requiring less chipping, and being more easily finished than a magnet frame made entirely of cast steel.

A material which a few years ago was quite a favourite with dynamo-builders, but which since has to a great extent been displaced by the cheaper cast steel, is the so-called "Mitis metal," or cast wrought iron, obtained by melting down scrap wrought iron in crucibles, and by rendering it fluid by the addition of a small quantity of aluminium. The trouble with this material was that a great many extra precautions had to be taken to procure sound castings, and that as a rule the castings were rough and difficult to work on account of their toughness. The magnetic value of Mitis metal differs very little from that of cast steel, its permeability at the inductions used in practice being but a trifle lower than that of the latter.

Edges and sharp corners are to be avoided as much as possible, for if they protrude sufficiently they will act, to a certain extent, as poles, and give cause to a source of loss. In castings, thin projections are apt to chill while being cast, thus making them quite hard and destroying their magnetic qualities; when necessary for mechanical reasons they should therefore be cast quite thick and massive, and may afterwards be planed or turned down to the required size.

(*b*) *Shape.*—The pole-pieces have for their object the trans-

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mission to the armature of the magnetic flux set up by the field magnet, and the establishment of a magnetic field space around the armature. The shape to be given to them must therefore effect the concentration of the lines of force upon the armature and not their diffusion through the air. This, in general, is achieved by making the polar surfaces as large as possible and bringing them as near to the armature as mechanical considerations permit, and by reducing the leakage areas of the free pole surfaces as much as possible. For practical rules of fixing the distance between the pole corners and the clearance between armature surface and pole-pieces for various kinds and sizes of armatures, see Tables XLVII. and XLVIII., respectively.

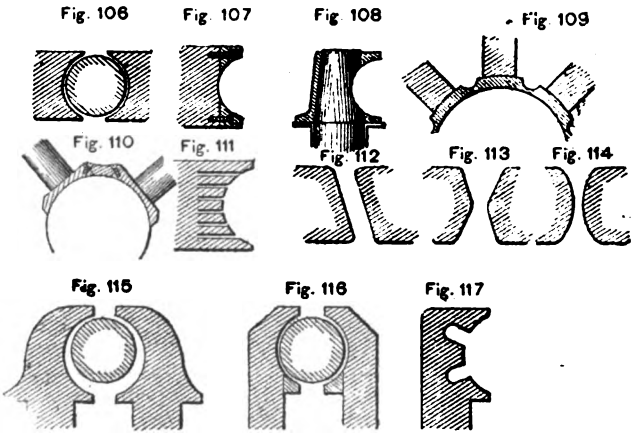
Since Foucault or eddy currents are produced in all metallic masses, either by their motion through magnetic fields or by variations in the strength of electric currents flowing near them, the pole-pieces of a dynamo-electric machine are seats of such currents which form closed circuits of comparatively low resistance, and thereby cause undue heating. These currents are strongest where the changes in the intensity of the magnetic field or of the electric current are the greatest and most sudden; this is the case, and consequently the eddy currents are strongest at those corners of the pole-pieces from which the armature is moved in its rotation, for owing to the distortion of the magnetic field by the revolving armature a density greater than the average is created at the corners where the armature leaves the pole-pieces, and a density smaller than the average at the corners where it enters. In order to reduce and eventually to avoid the generation of these eddy currents in the pole-pieces, as well as in the armature conductors, it is therefore necessary to prevent the crowding of the magnetic lines towards the tips of the pole-pieces, and to so arrange the poles that the magnetic field does not suddenly fall off at the pole corners, but gradually decreases in strength towards the neutral zone. This object in a smooth-armature machine can be attained (1) by gradually increasing the air-gap from the centres of the poles towards the neutral spaces in boring the polar faces to a diameter larger than their least diametrical distance apart, thus giving an elliptical shape to the field space, as illustrated in Fig. 106; (2) by providing wrought-iron pole-pieces with cast-iron tips forming the pole corners and terminating the arcs embraced by the pole faces (see Figs. 107 and 108); or (3) by establishing a magnetic shunt between two neighbouring poles in connecting the pole-pieces either by a cast-iron ring of small sectional area (Dobrowolsky's pole bushing), or by placing thin bridges across the neighbouring pole corners, as shown in Figs. 109 and 110 respectively.

The ellipsity of the field space has the advantage that it confines the lines of force within the sphere of the pole faces by proportionately increasing the reluctance towards the pole corners, thus preventing an increase of the magnetic density at any particular portion of the pole-piece. The application of cast-iron pole tips with wrought iron (or cast steel) pole-pieces, does not prevent the crowding of the lines at the pole corners, but by reason of the low permeability of the cast iron, reduces their density to a figure below that in the wrought iron, and consequently effects a graduation of the field strength near the neutral space, the maximum density being in the wrought iron at the point where the cast-iron tips are joined. In the pole bushing, or its equivalent, the pole bridges, the reach of the magnetic field is greatly increased, the percentage of the polar arc being practically $= 100$, and also a more or less gradual decrease of the field strength at the neutral point is obtained, but the length of the non-sparking space is greatly reduced and thereby its uncertainty increased, thus making the proper setting of the brushes a very difficult operation.

It has also been recommended to laminate both the pole-pieces and the magnet cores in the direction parallel to the armature shaft in order to prevent the production of eddy currents, but this can only be applied to small dynamos, as the additional cost connected with such a lamination in large machines would be in no proportion to the small gain obtained. Besides, there is another reason against lamination; a laminated magnet frame is very sensitive to the fluctuations in the load of the machine, which naturally react upon the magnetic field, and in following these fluctuations an unsteady magnetisation is produced, which, in turn, again tends to increase the fluctuations, causing its variability; while in a solid magnet frame the eddy currents induced by the changes of magnetisation caused by the fluctuations of the load, tend to counteract the very changes producing them, and therefore exercise a steadying influence upon the field, thus reducing the fluctuations in the external circuit of the machine.

An expedient sometimes used, instead of laminating the pole-pieces, is to cut narrow longitudinal slots in the pole-pieces, Fig. 111, thus laminating a portion of the pole-pieces only. These slots at the same time serve to increase the length of the path traversed by the lines of force set up by the action of the armature current, and to thus reduce the armature reaction upon the magnetic field, checking the sparking connected therewith.

When the commutator brushes, after having short-circuited an armature coil, break this short-circuit, the sudden reversal of the current in the same, produced in passing the neutral line of the field, together with the self-induction set up by the extra current on breaking, causes a spark to appear at the brushes which may be considerable, since, in the comparatively low resistance of the short-circuited coil, a small E.M.F. is sufficient to produce a heavy current. If a dynamo, therefore, is otherwise well designed—that is, if the armature is subdivided into a sufficient number of sections, if the field is strong enough so as not to be overpowered by the armature, and if the thickness of the brushes is so chosen as to not short-circuit more than one or two armature sections each simultaneously, and as not to leave one commutator bar before making connection with the next strip—then the sparking at the commutator can be reduced to a practically unappreciable degree by so shaping the pole surfaces as to give a suitable fringe of magnetic field of graduated intensity, thus not only causing the current in the short-circuited coils to die out by degrees, but also compelling the coils to enter the field of opposite polarity gradually. This is achieved by giving the pole corners an oblique, or a double conical, or a hyperbolical form, as illustrated by top views in Figs. 112, 113, and 114 respectively.



For the purpose of counteracting the magnetic pull due to the armature thrust in bipolar machines, see Chapter 24, the pole-pieces are often mounted eccentrically, leaving a smaller gap-space at the side averted from the field-coils than at the side towards the same, Fig. 115; or, in case of wrought-iron or steel pole-pieces, cast-iron pole tips are used at the side towards the exciting coils, and wrought-iron or steel tips at the other, Fig. 116. Both the eccentricity of the pole faces and the cast-iron pole tips, if suitably dimensioned, have the effect of increasing the reluctance of the stronger side of the field in the same proportion as the density rises on account of the dissymmetry of the field, thus making the product of density and permeance the same in both halves.

(To be continued.)

Personal.—Mr. Brooke, the Director-General of Indian Telegraphs, will shortly vacate his appointment, having completed his five years of office. Mr. C. H. Reynolds, Deputy Director-General, will succeed Mr. Brooke as Director-General of Telegraphs, and Mr. P. V. Luke, C.I.E., now director of the construction branch, will succeed Mr. Reynolds as deputy director.

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ARC CARBONS AND THE RATING OF ARC LAMPS.*

BY L. B. MARKS.

The report made at the last convention of the National Electric Light Association by a special committee, recommending that what is ordinarily known as a 2,000-c.p. arc lamp shall be considered as one requiring on the average 450 watts for its maintenance, naturally suggests the enquiry as to how far the candle-power produced depends upon the watts consumed, and in the present paper attention will be confined to the part played by the arc carbon in this important relation. It is, of course, well known that the so-called 2,000-c.p. arc really gives a mean candle-power of only 300 to 600, the candle-power at the angle of maximum illumination seldom being greater than 1,200, and often as low as 700. In an elaborate series of comparative tests made by the writer several years ago there was found to be a variation of over 80 per cent. in the candle-power of commercial arc-light carbons consuming the same energy. Quite recently, Prof. W. M. Stine has reported on a number of tests, the results of which show a variation of about 30 per cent.

The difference in the quality of arc carbons was well brought out in a table of some tests made by the author, in which values were determined for the hissing point and the flaming point of various American and foreign products. In order to determine these values, a pair of carbons was placed in a lamp, and burned for 20 to 30 minutes. After the point had been well formed, the carbons were gently brought together until the arc hissed. A voltmeter connected to the terminals gave the potential difference. The lamp was then adjusted for a silent arc, and the mechanism so arranged that the rod was held rigidly. The carbons were then allowed to burn away until they flamed, the voltmeter being carefully watched meanwhile. Before the flaming point was reached the instrument would invariably fluctuate, due to "jumping" of the arc. At the flaming point there was a marked drop in the potential, as indicated by a voltmeter. Great care was taken to secure perfect alignment of the upper and lower carbons. An average of three different tests was made of each pair of carbons. The carbons were all intended for a current of from eight to ten amperes, 9½ amperes being used in the tests. The total length of a pair of carbons was 10in. in each case.

It was found that the range—that is, the difference in volts between the hissing point and the flaming point—varied greatly with different carbons; thus, while one carbon had a range of only 11·4 volts, with another it attained 34 volts. Both of these carbons are sold by representative American manufacturers, the former being a squirted petroleum coke carbon, and the latter a moulded coke carbon. The hissing point of the cored carbon averages over 10 volts lower than the solid. The hissing point of American cored carbons does not vary much from that of foreign, but the range of the latter is fully 10 volts greater than that of the former, and exceeds that of any of the American products tested, cored or solid. In the case of some makes of cored carbons tested it was impossible to measure the hissing point with any degree of accuracy because of the deposition on the negative of small portions of the core thrown out by the positive at low potential differences. The amount and nature of foreign matter in a carbon have much to do with the commercial efficiency of the latter, and determine to a large extent the range of the carbon.

It has been the desire of central-station men to obtain, and the aim of the manufacturer to produce, an absolutely pure petroleum coke carbon, thinking that this would, in a large measure, solve the candle-power question so far as uniformity is concerned. The writer is of the opinion, however, that an absolutely pure coke carbon, if such could be commercially manufactured for arc lamps, would not meet the requirements of central-station practice to-day. Two carbons tested were taken from two batches made with special reference to purity, and it was found that one of them hissed at 53·7 volts and the other at 52. To be operated at maximum efficiency, these carbons would require more than 55 volts at normal current, and under no conditions in practice would they give satisfactory service at less than 55 volts average—fully five volts higher than that of good commercial carbons. In connection with the potential difference required for maximum candle-power in a given case, it is interesting to refer to a test reported by Prof. H. S. Carhart, in which a pair of commercial carbons designed for use on full arc circuits showed a maximum efficiency at about 55 volts. These carbons at 10 amperes and 45 volts gave 450 c.p. Thus, it is of the utmost importance to the carbon manufacturer to test not only the range of his carbons but also the voltage at which they give maximum efficiency. The importance of steadiness in arc lamps has been very well shown by the introduction of cored carbons. Here, again, we are confronted with the question of candle power in relation to the consumption of energy. If we assume that a 450-watt arc gives nominally 500 c.p. with efficient solid carbon sticks, we must make an allowance of at least from 15 to 20 per cent. for reduction in candle power for the same energy, substituting an efficient cored carbon stick. Yet, for indoor illumination the consumer is better satisfied with the cored carbon than with the solid.

It would be entirely out of the question to designate a given current density for commercial light carbons, yet, in attempting to formulate a relation between candle power and energy expended in the lamp, the question of current density must necessarily be considered. Schreihage deduced the law that for homogeneous carbons of the same make the candle-power varies inversely as the diameter. He states that this relation, as is to be expected, is not completely satisfied in the case of the mean horizontal candle-power, especially when the carbons are very small or very large. When we consider that as a means for securing long life, flat carbons and "twin" carbons have been more or less used, we are reminded that in connection with the available candle-power per watt expended in the arc lamp, the shape of the carbon must be given due consideration.

A consideration of alternating-current arcs opens up another field in the discussion of candle-power wherein the carbon point plays an important part. In the commercial operation of alternating-current arcs, cored carbons are almost exclusively used. The constituency of the core has much to do with the efficiency of this type. The comparison of the candle-power of a commercial alternating-current arc with that of a direct-current arc consuming the same energy, as measured at the carbon points, shows that the former gives less illumination than the latter. So important is the relation of the carbon point to efficiency of the alternating-current arc that the substitution of a solid carbon for a cored carbon in this form may reduce the candle-power and decrease the efficiency to such an extent as to make the lamp unmarketable. Thus far we have discussed arcs which burn with free access of oxygen. In the case of enclosed arcs, or those which are operated in small bulbs to which the air has very limited access, the conditions that govern the relation of watts to candle-power for the open-air arc are more or less modified. With enclosed arcs purity of the carbon is very important, and in some applications of these arcs the objections which stand in the way of commercial utilisation of pure carbon electrodes in open-air arcs do not apply.

The importance of details in the manufacture of carbons cannot be over-estimated in the consideration of this subject. With the carbon maker rests the task of supplying a uniform and efficient product; but even with the best carbon product it would seem advisable to discard the term "2,000 c.p." or "1,200 c.p." as applied to arc lamps. Measurement of the wattage, provided for in the resolution of the committee on the rating of arc lamps, appears to be the true solution of the problem. The central station manager will undoubtedly find it to his interest to furnish good carbons, and if he demands them the carbon manufacturer will supply them. To quote Captain William Brophy, "The sooner you sell your light as power, the sooner this trouble will end, and I advise every man in the future to sell his lamp at 450 watts, or whatever is necessary, and bury out of sight the term '2,000 c.p.'"

* Abstract of paper read at the Cleveland Electrical Light Convention.

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THE DISABILITIES OF YOUTH.

We find that the article which appeared in our issue of February 22 under this title has been interpreted to contain a meaning far more intense than we imagine the author intended. Unfortunately, the editor has been absent from his duties and incapacitated by severe illness for nearly four months, otherwise modifications, which would have been made in the article, did not appear, and as the result some sentences may be twisted to mean that Mr. Crompton, in his position of president of the Institution, animadverted unnecessarily upon the capacity of trade competitors. We do not for a moment suppose that anyone who personally knows Mr. Crompton ever thought this, and as perhaps we have known him as long and as intimately as anyone connected with the industry, we must emphatically repudiate the idea of presidential advocacy of any particular system. Mr. Crompton's view is that the proper conclusion as to what is best is only to be obtained by a careful study of the conditions of the particular case under purview. He is not wedded to any particular system, but is ready to adopt the best as indicated by the particular case after careful examination.

"PREVENTION BETTER THAN CURE."

During the past few months we have had a long list of explosions connected with electric mains. By many it is thought unwise and unpatriotic to the profession to prominently call attention to them. In the opinion of others, not so; they arguing that the continuance of such explosions will lead to disastrous effects upon the industry; and we believe the latter view to be the correct one. Would-be adopters of electric lighting will be dissuaded by interested parties laying stress upon these dangers—dangers, forsooth, not unforeseen—but though avoidable not avoided. The engineers who have designed and carried out high-pressure systems of distribution are greatly to blame for not having had the foresight to prevent any explosion except in cases where the circumstances are not to be controlled. They know, or ought to know, in the first place, that wherever there is a system of gas distribution there is gas leakage, and there is a danger from such leakage getting into ill-ventilated conduits and manholes. These facts should always be glaringly apparent. The application of a light to a gas admixture with air in certain proportions will cause an explosion; if there is little or no air the gas will burn violently, but is in this case perhaps not so dangerous as when forming the admixture. But the gas or mixture will neither explode nor burn without the application of a light. It is all very well to point to certain cases where the light has come from a carelessly-thrown match from the hands of a casual passer-by. These cases are very exceptional. In the first place, there is the gas, which shows lack of proper ventilation. In the second place there is improper ventilation, otherwise the flame could not reach the gas, and this shows bad engineering, or bad workmanship, or bad superintendence, or something equally bad from a responsible source. Most of the explo-

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sions are undoubtedly caused by electric sparks. It is to the cause of such sparking that we once more desire to direct attention. The death of a bishop by a railway accident is said to be necessary to obtain a beneficial alteration of railway management. What, we may well ask, is necessary to obtain a proper disposition of wires and mains to obtain freedom from sparking? Looking at this matter from the common sense point of view, from the ordinary perception of an onlooker, it is well known that most of the explosions occur at manholes. The conclusion is immediate: there is something wrong about the arrangements of the contacts at the manholes, and if this is the case, then the designer or the carrier-out of the work at these manholes does not know his business. We distinctly assert that the fault is with either designer or worker, and whenever an accident occurs it should be thoroughly examined by experts which of these two should suffer. A short shrift to the man whose original blundering or carelessness caused the accident ought to be the motto of company or municipality. There is no need to jeopardise the lives and limbs of the community at large, and the man who does so ignorantly or wilfully is not a man to hold a position of responsibility. His place is in the backwoods, a hundred miles from his fellow men. But we have not done with our anathemas. For one fault that is found out by means of an explosion there are probably a thousand where a less dangerous discharge is periodically or constantly taking place. Each of these faults means deterioration of something—repair, earlier or later—a money loss to shareholders or ratepayers. Perfection is not attainable, but greater perfection than that too often allowed to pass is attainable, and should be insisted upon. These are young years in the electric light industry as yet, but if the history of mainlaying, alteration and repair could be written, it would create a sensation. Such history cannot be written. It would be libellous, and would blast the reputation of many among us who are thought to approach the immaculate as regards technical knowledge of this kind. The time to improve these details is now. It will be too late when the purchasing public, finding accidents occur in certain quarters and not in others, go blindly for those systems and engineers favoured by lack of accidents. Another succession of explosions similar to those which have been recorded the last few months will cause a revulsion of feeling against particular systems. Hence it is is imperative to thoroughly and exhaustively examine the details of the distribution arrangements. No matter the leakage of gas, the absence of a spark will prevent accident. Too much reliance ought not to be placed on ventilation. That is a palliation, not a prevention. The aim should be absolute prevention. The engineer who relies on ventilation is lost. It means no attempt to grapple with the weak point. It means an incentive to careless workmanship trusting to the system of ventilation adopted to prevent explosion. We suggest the old adage for the motto of all electric engineers, "prevention is better than cure."

ELECTRIC ANNEALING OF ARMOUR-PLATES.

This subject is discussed by Prof. Elihu Thomson in an article in the New York *Electrical Engineer* of March 6. The author states that soon after the introduction of the Harveyised plates it became a great desideratum to be able to locally anneal or soften the chilled surface to a depth sufficient to include all the hard steel at any particular point where it might be necessary to drill the plate in assembling it upon the warship under construction. Various means, such as the application to the surface of the most intense flames of the oxy-hydrogen blowpipe, were found ineffective to accomplish the result desired. The matter coming to the attention of the Thomson Electric Welding Company, was referred to its experts and pronounced by them to be capable of accomplishment by the passage of heavy currents locally through the surface of the plate. A number of experiments with sample pieces of plate did not, however, at first yield the desired results, and it was only by the establishment of a process of working or distinct method that the result could be accomplished. This method was devised by Mr. Hermann Lemp, the electrician of the Welding Company.

The process consists essentially in passing a current between two electrodes placed at a certain distance apart on the plate surface, and thereby heating a portion of the plate to an annealing temperature, after which, by a very gradual and careful diminution of the current, the temperature is slowly lowered, so that the too rapid cooling by conduction of heat to the massive plate-back of the heated portion shall be prevented from acting as a chill upon the heated metal. This provides that during the cooling there shall be a constant and continual application of the heating current and the production of heat, but at a rate which is made less and less, so that the metal back of the hardened surface, which is constantly abstracting heat, may be kept supplied, with the result that the fall of temperature at the heated or annealed spot may be controlled and kept such that no subsequent chilling takes place. The real object of annealing the spots on the armour-plate is, of course, to enable holes to be drilled through the surfaces and screw-threads to be cut into them by tapping, so that the plates themselves can be attached, or have other parts of the ship attached to them.

The apparatus used in the practice of the process consists of a dynamo furnishing alternating currents, these being such as are used in operating electric welding apparatus by the Thomson process. The currents from the dynamo feed the primary of a transformer, which is, in many respects, the same in general construction as a welding transformer. Instead, however, of the secondary terminals ending in clamps, they are simply blocks of copper cooled by water circulation, and separated a certain distance. These blocks are applied to the face of the plate under some pressure, and the current passing between the blocks heats up the metal between them, and here, as in certain welding operations, the fact of the use of alternating currents favours the concentration of the heating effect and the flow of current locally. The self-induction effect or reactance is least when the current flows near the surface of the plate between the electrodes, so that any current which branches from the electrodes and enters deeply into the plate not only has a longer path, but has a path in which the self-induction operates to limit the flow.

In actual practice with the apparatus at the Cramp shipyard it has been found that the results are highly satisfactory, the original apparatus being made to do with facility work in position and under circumstances which was not contemplated in its original construction, and for which other special arrangements were being worked out. The value of the process was more clearly demonstrated in the case of the warship "Massachusetts," which is under construction, as it was found that certain of the armour-plates for the barbettes were hard, or possessed the hard Harveyised skin, where it was absolutely necessary that they should be drilled and tapped. Indeed, it was impossible to properly attach the barbettes without making tapped holes in certain portions of these plates. Strenuous efforts had been made to accomplish the result by blowpipes, and such means did not succeed, while during these

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trials the building of the upper deck was delayed, until the proper securing of the barbette plates had been accomplished. On the appearance of the electric annealing apparatus at the yards it was soon turned to the accomplishment of this work for the "Massachusetts," so that there was no further need of delaying the work on the ship from the cause mentioned.

ELECTRIC RAILWAYS AND TRAMWAYS IN EUROPE.

Good service has been done by our contemporary *L'Industrie Electrique* in the past in the publication of statistics relating to central stations and electric tramways and railways in Europe. Our contemporary has now printed in its issue of the 10th inst. details of the electric railways and electric tramways in operation, in course of construction, or projected on January 1, 1895. These statistics show that the number of lines worked has increased from 43 in January, 1894, to 70 on the first day of the same month of the present year; that the total length has increased from 189 miles to 434 miles in the same period; that the power of the generating stations has advanced from 10,650 kilowatts to 18,150 kilowatts; and that the number of cars and locomotives has risen from 538 to 1,236.

The accompanying table indicates the total lengths of the lines at work in various countries, together with the number of cars in service, and the kilometrage now being constructed in those countries.

Country.	Lines in operation. Length in kilometres.	Number of cars.	Lines in construction. Length in kilometres.
Germany	366·17	632	94·59
England	68 80	125	34·20
Austro-Hungary	44·90	129	3·75
Belgium	21·70	48	—
Bosnia	—	—	5·60
Spain	14·00	12	—
France	96·26	152	46·00
Italy	18·85	33	22·80
Sweden & Norway	6·50	11	—
Portugal	—	—	12·80
Roumania	5·43	15	—
Russia	10·00	32	—
Servia	10·00	7	—
Switzerland	37·40	40	2·74
	700·01	1,236	222·48

It will be seen from the above figures that Germany heads the list with 366 kilometres of lines; France comes second with 96 kilometres, and England a bad third with 68 kilometres. It is noteworthy that of the 70 lines worked, no less than 55 are operated on the trolley system, eight on the central rail method, four with accumulators, and three on the underground conductor system. Our contemporary gives the maximum gradients as being as great as 10·5 per cent., and up to 35 per cent. where rack rails are also used.

At present 28 lines are being constructed, with a total length exceeding 200 kilometres. It is expected that these lines will be set in operation this year. *L'Industrie Electrique* erroneously gives the name of the Electric Construction Company as the owners of the Liverpool line, instead of the Liverpool Overhead Railway Company. The complete tables can be recommended to those desiring to possess details of towns, contractors, systems adopted, gauge, generators, motors, etc.

STEAM-ENGINE ECONOMY: CONDENSING ENGINES.

A paper on this subject by Mr. Henry Davey, M.I.C.E., was read at the ordinary meeting of the Institution of Civil Engineers on Tuesday, Sir Benjamin Baker, K.C.M.G., vice-president, in the chair.

The author pointed out that the principles upon which the development of the steam-engine, as regards economy of steam, were founded, had been understood in the time of James Watt, who had shown that gain might be expected to result from increased expansion, and had also explained that in order to obtain the full benefit of expansion the steam-cylinder must be maintained at a high temperature. Trevithick, Sims, Grose, and others had perceived that increased expansion, and consequently increased economy, might result from the employment of higher pressures. As early as 1844 the Cornish engine had been, for the steam-pressure then practicable, a more efficient engine than any other subsequently produced. Some Cornish engines at that time produced 1 i.h.p. per hour for a consumption of 19lb. of steam at a boiler pressure of 30lb. per square inch. Their efficiency was thus greater than that of modern triple-expansion engines giving 1 i.h.p. per hour with 13lb. of steam at a pressure of 120lb. per square inch in the boiler. The triple-expansion engine was more economical because it was worked at a higher pressure and at a higher rate of expansion; but it did not utilise the pressure and expansion so efficiently as the Cornish engine had done. A period of 67 years had been required for the development of the principles enumerated by Watt, Trevithick, and Grose; and upwards of 40 years for the reduction of the consumption of steam from 19lb. to 13lb. per i.h.p. per hour, or, in other words, for the diminution of the coal bill by one-third. In these advances no new principle has been applied, and no higher efficiency obtained.

The author had collected many examples of steam-engine trials in which the mean indicator diagrams were available, and the total feed-water per indicated horse-power per hour was known. These he had submitted to analysis to localise the losses. The mean indicator card of a given trial having been selected, a saturation curve was delineated to represent an assumed standard for a jacketed engine, working with the steam-engine cycle, and with no losses. This figure having been completed, the losses which make up the difference between the actual and the standard diagram could be readily separated, and their relative importance ascertained. The "engine efficiency" was expressed as the ratio between the mean pressure of the indicator figure and that of the standard engine diagram. The diagrams being drawn to a scale convenient for the use of the planimeter, the area of the waste spaces could be measured and expressed as a percentage of the full area of the diagram. These waste spaces represented cylinder condensation, etc., including condensation in the jacket, clearances, compression influences being taken into account when they were considerable, and back pressure. Having submitted a considerable number of examples of different types of engines to this method of analysis, the author showed that the economy of steam obtained by modern engines was simply due to increased pressure and increased expansion, and that the engine-efficiency or the percentage of work obtained from steam of a given pressure and given rate of expansion, referred to the standard selected, was lower in modern engines than in the Cornish engine 30 or 40 years ago. It was also seen that the loss in power arising simply from the cooling influence of the cylinder walls was not, in jacketed engines, at all events, so serious as was sometimes supposed. It was stated that the method gave practical results, and enabled defects in the steam distribution to be readily ascertained; also, that the engine efficiency obtainable from a given steam distribution afforded a proper gauge of the value of that mode of distribution in point of possible economy. The average engine efficiencies, ratios of expansion, and initial pressures for the examples given were:—

	Engine efficiency.	Lbs. of steam per I.H.P. per hour.	Rates of expansion.	Initial pressure.
Cornish	73·0	21·0	3·65	33
Single cylinder	66·0	23·5	3·95	76
Compound	64·0	18·5	7·73	84
Triple expansion	64·4	14·8	14·5	138

The best results in individual cases, fully detailed in appendices to the paper, were much higher.

The Cornish cycle had been devised for pumping-engines in the early days of the steam-engine in Cornwall. Its effect was to maintain the working part of the cylinder at a higher temperature than would be the case if the steam were discharged directly into the condenser. It reduced initial condensation, and by this means increased the engine efficiency. The Cornish engine showed the highest engine efficiency, but it had become obsolete with the adoption of high-pressure steam, and of other less cumbersome

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machines giving superior economy. It embodied, however, the principles of the most advanced modern steam-engine practice. The greater economy of more recent engines resulted from the use of higher pressure and of greater range of expansion. The compound engine utilised the principle of the diminution of the range of temperature in the cylinder which was embodied in the Cornish cycle, but the triple-expansion engine did so more completely. In the compound engine the loss was larger with the Woolf distribution of steam than with the receiver engine, because in the Woolf engine the cylinders were subjected to a greater range of temperature, and there was greater loss of pressure between the cylinders. In an example of the triple-expansion series, given in an appendix, the loss from cylinder condensation was about one half of the total loss, or, say, 14 per cent. of the power represented by the standard diagram. The losses from clearances and back-pressure each amounted to about 7 per cent., so that the total average efficiency was about 70 per cent. The latter losses were nearly constant in well-made engines, and, therefore, the remaining loss of 14 per cent. was the only one which admitted of considerable reduction, unless it could be shown that the assumed diagram showed too low a standard. Pumping-engines, notwithstanding the low speed at which they worked, had always been among the most economical of steam-engines. As previously stated, the Cornish engine, which was a non-rotative engine, gave a higher engine efficiency than any other. The limit of econonomy had, however, been reached, because it could not be worked at a higher steam pressure, nor with a greater ratio of expansion. The Cornish cycle might be made to give increased economy by a method which appeared to have hitherto escaped notice. The steam, which had done its work and had passed the equilibrium valve, possessed considerable pressure and temperature, say, a pressure of 10lb. per square inch and a temperature of 194deg. F. If a connection, having a non-return valve, were made to a feed-water heater from the equilibrium pipe, the feed-water could be heated to, say, 180deg. F. on its way to the boiler. This possible element of economy invested the Cornish cyle with additional importance when the question of steam-engine economy was considered.

The Gilgit Telegraph.—The following message was recently sent by the Director-General of Indian Telegraphs to the superintendent of the Kashmir telegraph division: "Please telegraph to Messrs. Comber and Johnson, of Gurais, Messrs. Dalby and Smith, of Minimerg, and Mr. Higgins, of Astor, that I am watching with great interest the state of communication with Gilgit, and I wish to congratulate them on the courage and determination they show in successfully repairing the line in the face of great difficulties and danger, which I thoroughly appreciate and understand." The *Indian Engineer* states that it was a bold venture to undertake the erecting of an aërial line of wire over the Tragbal and Burzil Passes, and bravely did Mr. Olpherts and his staff carry it out, and in so doing established communication between India and the spot "where three empires meet." Few who read the telegraphed messages from Gilgit are aware of the political importance which attaches to this line of communication, or how essential it is that its efficiency be maintained, and that Dr. Robertson, the political officer at Gilgit, and his little force be kept in constant touch with the Government. In order that this should be done it was not only necessary to erect the line, but also to adopt very special measures for its maintenance, and the restoring of communication after an interruption. It did not require much of the gift of prophecy to say that interruptions would be frequent, and the task of restoring the damaged line, in these storm and snow-swept heights, dangerous in the extreme. For the more ready means of keeping up the line during the severe winter months, it was divided into sections, and besides the regular telegraph station at Astor, two intermediate stations, one at Gurais, at a level of 8,100ft., and the other at Minimerg, an elevation of 9,800ft. above sea-level, were opened.

ZURICH CENTRAL STATION.

Some details have been published in *L'Industrie Electrique* concerning the working of the Zurich central station during 1893. Although somewhat belated, the information is interesting from several points of view. The station contains 10 Henschel-Jonval turbines running at 100 revolutions and transmitting on an average 1,000 h.p. to a main shaft arranged longitudinally in the station. From this shaft are driven seven sets of pumps which, among other duties, feed a reservoir arranged at a height of 150 metres. A second shaft, which is also actuated from the first, drives four alternators (one of which is spare), each of 300 h.p. Two 300-h.p. high-pressure turbines, supplied from the reservoir mentioned, are mounted on the second shaft. The exciting current is furnished by generators driven from a third shaft.

As the station had to be continuously in operation, it would, of course, not be economical to run all the plant during the time of light loads. Consequently a 100-h.p. dynamo, actuated by belt from the main shaft, has now been installed for service during the day. When the demand increases, the 300 h.p. alternators and turbines are thrown in and the small machine stopped. The current is transmitted at a pressure of 2,000 volts by means of three Berthoud and Borel cables, a distance of 1½ miles to the town, when it is transformed down and distributed to consumers.

As a result of measurements made every week it has been possible to ascertain with sufficient exactness the efficiency of each part of the system. The following figures show the efficiency in percentages:

	First half-year.	Second half-year.	Average for the year.
Efficiency of transmission from motors to generators	79·1	86·8	83·0
Efficiency of the generating system without the transmission	69·1	77·7	75·6
Efficiency of the system, including transmission	54·7	67·4	61·1
Efficiency of the distributing system	71·6	74·2	73·0
Total efficiency without transmission	49·5	57·6	54·0
Total efficiency with transmission	39·2	50·0	45·0

Our contemporary mainly attributes the low total efficiency to the losses due to transmitting power from the motors to the alternators, particularly as a day-load machine was not installed in the period under consideration, and to losses in the transformers. At the same time the financial position of the undertaking is considered to be excellent.

ATLANTIC CABLE REPAIRING.

An interesting paper has been read before the Kearsarge Association of Naval Veterans, in Boston, by Captain Samuel Trott, of the s.s. "Minia," the repairing ship of the Anglo-American Telegraph Company. The following extract gives an idea of the amount of repairing required to keep these cables in working order:

From what has already been said you may infer that submarine telegraph cables have only a precarious existence, which is more or less true; therefore every precaution should be taken by those laying them to guard against impending dangers, for when breaks occur in deep water the cost of repairs often amounts to fabulous sums.

Two of the first cables laid in the Atlantic lived about seven and ten years respectively, when they were broken in deep water. Two attempts were made to repair one, and one attempt was made to repair the other. These three expeditions cost in the aggregate about 1,000,000dol.; both cables were then abandoned. A few years later a fault was cut out of another cable in mid-Atlantic at a cost of 400,000dol. Such enormous expenses and repeated failures forced the managing director of the Anglo-American Telegraph Company to look for some more certain and expeditious means of getting his deep-water repairs effected, so toward the end of the year 1883 he decided to equip the "Minia" for this important work (she hitherto having been fitted for shallow water only). Time has

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fully proved the wisdom of that decision, her record since then being without parallel in the annals of submarine telegraphy, having accomplished about 120 repairs in the last 10 years (and not a single failure to record against her), although many of them were in the deepest water of the Atlantic, the last of which reaching the enormous depth of 2,597 fathoms. This may be considered the "Minia's" greatest achievement, for not only did she have many unforseen difficulties, which seemed almost insurmountable, to contend with, but there was the fact that another ship, nearly double her size, had the previous summer spent the greater part of four months in the attempt and had failed.

There has also during last year been another failure to record by a still larger ship (claimed to be the best equipped for this work of any in existence). Nearly four months were consumed in fruitless efforts. The expense of these two failures may be estimated at not less than 300,000dol. for ships alone, in addition to which must be added the cost of cable required to replace that which had been destroyed by hacking it to pieces in the continued efforts to recover it.

THE MONOCYLIC SYSTEM.*

BY DR. LOUIS BELL.

To the central station man no recent change in engineering practice can have more interest than the renaissance of alternating current work which is now in progress. Truth to tell, until quite recently the alternating current was somewhat under a cloud in the estimation of both station managers and engineers. It had served an immensely useful purpose in the extension of electric lighting to places where it would have been utterly impracticable to instal a direct current system of any sort, on account of the scattered nature of the work. A very large number of stations have been installed on the alternating system, and I am sorry to say that a large proportion of them have been somewhat unsatisfactory, not in their general operation, but in the character of their service and the commercial results. It is quite common to find alternating stations with a plant efficiency considerably below 50 per cent., and in which the regulation is maintained only within, perhaps, about 10 per cent. Under these circumstances it is small wonder that the advocates of the direct current, the uses of which as an engineering problem have been very completely worked out, have been often somewhat violent in their animadversions on alternating currents in general. Nevertheless, in the last two or three years there has been a vast change for the better in alternating practice, a change not yet rapid, but bidding fair to be far-reaching. This change has taken up a three-fold path towards progress:

First, the use of large transformers is becoming more frequent. Next, these transformers are more and more used with systems of secondary mains; and, finally, it is now possible to install an alternating plant that shall be able to operate motors as successfully as can be done with direct current. In ordinary central-station practice the motor service does not usually play a very important part; nevertheless, the ability to run motors is most valuable. It is more profitable, speaking broadly, to sell current for light, for a better price per kilowatt hour can be obtained; at the same time, if motors can be readily furnished, a useful day load can be obtained when it is needed, and the plant becomes the greater service to the community, a thing which, in these days of more or less friction with common councils, is of no small importance. Not only can motors now be successfully worked off alternating circuits, but off a wide variety of such circuits. As yet, however, there is no successful motor for use on the simple alternating system which has, for the most part, been installed in this country. While it is possible to construct a single-phase motor even for 120 to 130 cycles per second, the frequency most used in America, it is at present very doubtful whether such a motor can be made to start and run in a way which will be generally satisfactory. Abroad, where low periodicities are used, better results may be obtained; but, even there, there is a noticeable silence on several important points in describing alternating motor practice. Appearances indicate that, even with the advantage of low frequency, motors for use on simple alternating circuits still start badly, and particularly require enormous currents at the moment of starting; hence the growth of various modified alternating systems, of which the polyphase is the best known, by the use of which it becomes possible to avoid this difficulty entirely, and to work alternating-current motors in every respect as satisfactory as those operated by direct current.

The polyphase motor has solved the problem of securing good motor service with alternating currents in a very complete manner, although at the cost of slight complications, which, while generally over-estimated, are, nevertheless, distasteful to central-station men, especially where the use of such a system would involve an extensive and costly rearrangement of the distribution service. It is the purpose of this paper to call your attention to the various methods of central-station distribution, involving motor service on the alternating-current system, and more especially to a modified single-phase alternating system, which lends itself very readily to a very simple and straightforward distribution for lighting, without sacrificing the excellent motor service, which makes the true polyphase systems so desirable. For all around central-station work the lighting service is of most fundamental importance, and convenience and economy in this particular must, in a vast majority of cases, be the first consideration. Let me invite your attention to this chart, which shows in a diagrammatic manner the general arrangement of various alternating circuits, including those already familiar and the polyphase and monocyclic systems.

First in order, both of time and extended use, comes the simple alternating system, single phase, with an ordinary two-wire distributing circuit. In operating the secondaries of such a system, we run immediately into limitations imposed by the feasible voltage for lamps, limitations which have acted as a brake on alternating-current work, and which are responsible for a good many difficulties in the operation of alternating plants. Opposite the diagram of this circuit I have placed the relative amount of copper required for lighting with such a distribution.

Next comes the alternating circuit modified for Edison three-wire distribution, which is so familiar in its character that it needs no description here. The amount of copper needed, on the supposition that neutral is half the size of either of the others, is, of course, enormously reduced, amounting, as you see, to less than one-third of that needed with the two-wire system; consequently, the secondary main distribution, so important to economical operation, can be carried out with the greatest facility. We are justified at present in saying that neither of these systems lends themselves to the ready operation of motors.

We may next consider the two-phase alternating system worked with four wires, giving, if desired, two separate circuits for each machine. The copper here required is the same as that used with the single phase, and so long as the four wires are kept together motors can be freely operated. Here is assuredly a step in advance. The operation of two separate circuits, however, from a single machine, involves certain complications. In the first place, unless these circuits are balanced as to load, the operation of the system is somewhat difficult to make satisfactory in point of regulation. The circuits themselves have absolutely no influence on each other, but they are derived from the same machine, and with a given excitation of that machine, unless the loss in the two circuits is the same, the voltages must necessarily be different, consequently the generator cannot be compounded for both circuits unless the circuits are balanced. There are three ways out of this difficulty; none of them, unfortunately, are altogether unobjectionable.

In the first place, one can make the loss on the line so small that the difference in voltage due to any reasonable difference in load is of no moment. This can sometimes successfully be done, but more often it involves a very unnecessary cost for copper, and even at its best is likely to give regulation which, although better than that found on most simple alternating systems, is yet not good enough to suit the requirements of the best modern engineering.

* Paper read before the National Electric Light Association, Cleveland.

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Second, the machine can be compounded for loss on one of the lines, a feeder regulator being used on the other. This practically means hand-regulation of one circuit.

Or, finally, both circuits can be operated by such regulators. In any case, if motors are to be operated, the two phases must be interlinked at least by one wire.

A somewhat simpler two-phase distribution is that shown in the next diagram, where the two phases unite into a common three-wire circuit. The amount of copper here

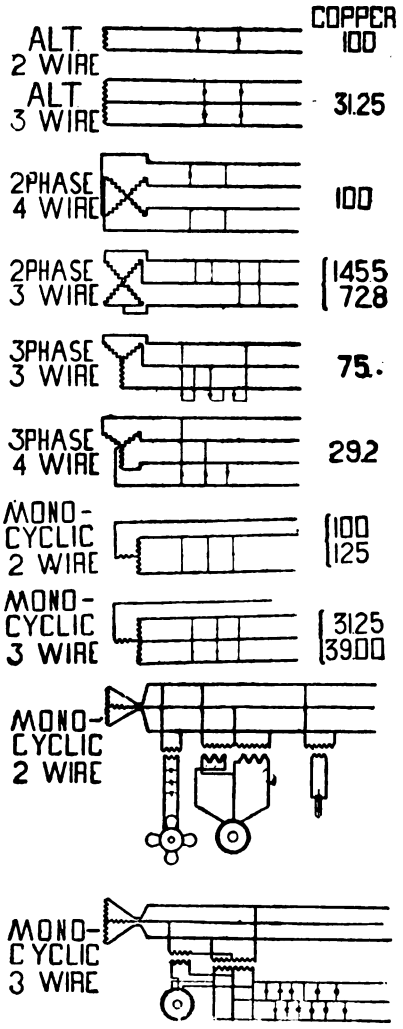

Diagram illustrating different Systems of Distribution.

required differs very materially, according to the limitations of voltage that one chooses to fix. If the maximum voltage of the system is limited to the same maximum voltage used on the single-phase two-wire or two-phase four-wire system, the amount of copper required is very largely increased by the use of the third wire, owing to the fact that the two circuits combined are out of phase with each other by 90deg. The relative amount of copper required here is, as you see, 145·5. If, on the other hand, the question of maximum voltage between wires is neglected and the voltage is determined by the use of lamps of the same voltages as on the other systems, then the amount of copper is materially reduced, being a trifle less than three-fourths of that required on the systems before mentioned. In this case, we neglect the fact of their being an excessive voltage between the outside wires, and connect lamps between the middle wire and the two outside ones much in the manner of an Edison three-wire system, with the exception, of course, that the saving in copper is not anything like the same amount. Such a system allows the distribution of the whole load for lights and power in a single circuit containing only three wires. It therefore avoids the difficulty of regulating two separate circuits. On the other hand, it causes a new and very curious difficulty, owing to the fact that the two combined phases are unsymmetrical with regard to the inductance of the system. The voltages between the middle wire and the two outside wires are unequal, when the systems are equally loaded, by an amount depending on the inductive loss on the line. Consequently, when in balance for regulation, the system is unbalanced as regards the load on the two sides, a condition which, although it may not lead to trouble in some cases, is still a menace to the successful operation of the system, unless the distribution be skillfully engineered. There is, however, the possibility of a noticeable saving in copper.

We may next pass to the three-phase alternating system. The system which corresponds to the two-phase four-wire system I pass by, as the use of three separate circuits would be even more troublesome than that of two, and would have no compensating advantages. The ordinary three-phase circuit is that shown in the figure wherein the three phases are united into three wires and taken everywhere where the motors and lights are wanted. In this case, for the same voltage between wires, the amount of copper demanded is just three-fourths of that demanded for a single-phase two-wire or two-phase four-wire circuit. To compensate for this, there is the possibility of unequal voltages in case the three legs of the circuit are unequally loaded, owing to interaction in transformers and in the generator. So far as inductance on the line is concerned, the system is symmetrical and balanced.

If the load on the three branches is very unequal, as, for example, if one branch is entirely unloaded or very lightly loaded, while the other two are worked to their full capacity, there will be a perceptible unbalancing of the voltage. Experience, however, shows that with anything like the same care in balancing that would apply to an Edison three-wire system, this theoretical difficulty of balance is absolutely negligible. I say this advisedly, as the question has been so often raised that I have taken pains to investigate the conditions in three plants operating lights with reference to this particular thing, and the statement just made is the result of actual practice. It might be thought at first sight that good results could be obtained by combining with either a two-phase or three-phase system the Edison three-wire distribution. As a matter of fact, such a system would be unreasonably complicated with either two or three phases, as any central-station man will readily appreciate, inasmuch as it would be necessary to have two or three wire systems, each balanced, and mutually balanced with respect to each other, covering the territory if motors are to be run, or, at least, interlinked in a somewhat complicated way.

There is, however, a three-phase system which does secure a very great advantage in copper. This is the three-phase four-wire system shown in the figure. It consists of the ordinary three wires employed on the three-phase system, with the addition of a balance wire proceeding from the common connection of the generator or the transformer, and forming a part of the general distribution system. The lights are, as can be seen from the diagram, connected between either of the three-phase wires and the balance wire. Between each of the outside wires there is, therefore, what may be considered two lamps in series, having, however, a phase difference of 120deg. The voltage of transmission, then, between each of the three main wires is 1·73 times the voltage employed in the lamp connected, nearly 200 volts for 110-volt lamps. This necessarily means a large saving in copper, which is still further enhanced by the fact that the three-phase three-wire system requires intrinsically only 75 per cent. of the copper used on the single-phase or direct-current system. The total result with this particular connection is but 29½ per cent. of the copper required on the single-phase system, supposing, as in the Edison three-wire distribution, the neutral wire to be half the size of either of the other. Such a system is in successful use at St. Hyacinthe, Canada, in connection with long secondary mains. The price paid for this saving in copper is the introduction of a fourth wire into the distributing system.

Comparing, then, the lighting distributions on the two and three phase systems, we find that if three wires only are used both save very nearly the same amount of copper. The extreme voltage between wires on the two-phase circuit is, however, considerably greater, and both are liable, but not likely, to become unbalanced.

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There is this difference, however, that if we are to balance a three-phase system in respect to voltage we need only to see that the load is equally distributed between the three branches. If we are to balance a two-phase three-wire system, we must see that this load is unequally distributed between the three branches by an amount depending on the inductance of the line. We, therefore, see, comparing the polyphase with the single phase system, that the price we have to pay for the privilege of successfully operating motors is a certain amount of complication in circuits, which, while not of great importance in new installations, hinders the ready adaptation of a polyphase system in a plant having already a large number of circuits installed. Attractive as the single phase is in its beautiful simplicity of wiring, we cannot yet successfully run motors from it.

It was for the purpose of preserving that simplicity of distribution which is peculiarly valuable in connection with large central stations, especially those already installed, and joining to this the same ability of running motors found on the polyphase system, that the monocyclic system, to which I am about to call your attention, has been perfected. You see it first in its two-wire form. Here, so far as the lighting distribution is concerned, it is absolutely indentical with any of the alternating systems now installed in simplicity, convenience, and in the amount of copper necessary. The main circuit of the monocyclic machine constitutes a simple single-phase alternator, and, so far as the lighting on the system is concerned, is identical with it, connected in precisely the same way, feeding, if desirable, into the same circuits without change. There is, however, on the armature of the monocyclic machine a supplemental coil, shown on the diagram as connected to the middle point of the main winding on the monocyclic machine, from which a power wire may be led. This need be of but small cross-section, and only has to be carried to those points in the system at which it is desired to operate motors, and, as I shall presently show, this power wire enables one to run motors possessing the same desirable characteristics as the polyphase motors, and, indeed, generally identical with them, without in any way distributing the lighting distribution, except in so far as Ohm's law is a necessary limitation on all combined power and lighting circuits. In the last diagram here we see the same device applied to an Edison three-wire system for the distribution of lights, along with which is carried the same insignificant power wire, which permits the successful operation of motors. The value of the three-wire feature in the distribution of lights is evident, the amount of copper being the same as in an Edison system of the same voltage. With this monocyclic system we can compound the generators for any reasonable loss in the line, and can arrange the lighting system without incurring any troublesome questions of balance, so as to give as good regulation even as can be obtained on a direct-current system. Beyond this we have the power of running motors.

It is instructive to glance over this list of alternating lighting systems to see their relative complexity and advantages. It is especially noteworthy that any and every method of distribution that saves copper introduces in some form or other the question of balance. This is the price we pay for reduction in cost of conductors. It has not seriously interfered with the use of the Edison three-wire system; in fact, those most familiar with that system were the first to make light of the difficulty; nor do I think it stands as a valid objection to the use of the polyphase systems in cases where they are desirable, as none of them are more sensitive in the matter of balance than the Edison three-wire system which is now in such extensive and uniformly successful use. We may further note that in each of the alternating systems, where a very great saving of copper is accomplished, a fourth wire is necessary, at least if both lights and motors are to be operated, in each case, however, of trifling size. Having now looked over the field in general, we may pass to the more minute consideration of the somewhat striking electrical peculiarities of the monocyclic system; peculiarities which, although they do not involve any particular complexity, are yet of decided interest.

The general principle of the system is well shown in this diagram. So far as the main work of the generator is concerned, its winding is closely similar to that of any well-designed alternator. The armature is of the iron-clad type, and the winding is made in machine-wound coils, which are invariably insulated, and can be very readily slipped into place. There is, however, upon the armature a second set of coils of cross-section equivalent to that of the main coil, but composed of comparatively few turns, so that the room taken up on the armature is very small, and owing to the shallowness of the slots necessary to accommodate this second or teaser coil, the output of the machine, considered as a single-phase generator, is not affected. This teaser coil is located with reference to the main coil as shown in the diagram. Its place on the armature is midway between the other coils, and the E.M.F. generated is in a direction at right angles to that of the principal coil. It is evident, now, that if we connect the terminal of this teazer coil with either of the terminals of the main coil we shall get an E.M.F. compounded of the two and in some intermediate direction. In general, by varying the proportions of the two coils, and hence their E.M.Fs., we could obtain a resultant E.M.F. between their terminals having any angle we pleased with either the main or the teaser coil. If, then, wires are taken upon the line from the terminals of the main coil and also from the teaser coil, we can obtain from the main line three E.M.F.'s, two of which are symmetrically situated with reference to the E.M.F. of the teaser coil, and bear to it any phase relation that we please. One of the most convenient arrangements, and that which is most generally adopted, involves such a relation of the E.M.F. of the teaser coil to that of the main coils, that we shall have on the line three E.M.F.'s approximately 60deg. apart. In other words, the resultant E.M.F.'s between teasers and main coils are each 60deg. from the E.M.F. of the teaser coil. Such an arrangement is that shown in the diagram. Under these circumstances, it is clear that if one of these E.M.F.'s were reversed, either in transformers or anywhere in the translating devices, the result would be three E.M.F.'s 120deg. apart, one of them having been turned through an angle of 180deg. Meanwhile, the relation between the power wire, which is connected to the teaser coil and the outside wire has no effect upon the E.M.F. between these outside wires, since the E.M.F. of the main coil itself does not interact with the power wire, except in so far as a portion of it may act with the power wire to form a resultant phase, and E.M.F. for running motors. Consequently, so far as lights are concerned, the two outside wires behave precisely like the leads from any other alternating generator, while so far as motors are concerned we have the power of getting our three E.M.F.'s 120deg. apart, and hence have the same magnetic effect as with a three-phase system. The arrangement of lights and motors with this device is clearly shown in the diagram. It is evident that we can take from the outside wires of the monocyclic system either arc or incandescent lights anywhere and to any extent the capacity of the machine permits, working for the incandescents either two or three wire distribution at option. For a motor, two transformers are connected anywhere we please, one between the power wire and each of the outside wires. At this point the resultant phases come into play, and the necessary reversal of one of the E.M.F.'s is accomplished by the very simple and obvious device of reversing one of the secondaries, as shown in the diagram. To the secondary circuit thus constituted we can connect a standard induction motor, which will start and run as well as if connected to a regular three-phase system, or instead of reversing one of the transformer secondaries we may accomplish the same virtual reversal of the E.M.F. by reversing one of the coils in the motor itself. We therefore have a system which, so far as lights are concerned, is a simple alternating system; so far as motors are concerned, the dynamical equivalent of a polyphase system. With a differently proportioned transformation we could place upon the secondaries two E.M.F.'s 90deg. apart, if necessary, and then run two-phase motors instead of three-phase motors, if there were any object is so doing. Such an arrangement, however, would be less desirable than that of the quasi three-phase system, for the reason that without gaining anything in the motors we should have to

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generate a larger E.M.F. in the teaser coil, and hence take up more room on the armature with it, perhaps enough to have an effect upon the output of the machine considered as a single phase generator.

It is sufficiently evident that the method shown would not be the only way of getting the same result. For example, in this second diagram a somewhat different arrangement is shown accomplishing precisely the same end. Here our object is to operate secondary mains on the Edison three-wire system, and in connection with them to run motors at any point we please. A large transformer to which the secondary is connected on the three-wire system is therefore installed, and the secondary mains distributed in any manner we please. A second and small transformer, proportioned to the total amount of motor service desired, is connected as shown in the diagram, and the power wire leading from it is taken through the whole or part of the three-wire system. The device is analagous to the arrangement of the generating coils themselves, and the result is the ability to operate a standard induction motor by connecting it anywhere on the three-wire system to the two inside wires and to the power wire. Such an arrangement as this is immensely convenient in distributing power and light in cities where, for example, it is desired to establish an extensive system of secondary mains through Edison tubes or other convenient underground distribution. It is, furthermore, interesting to know that one is not confined to the use of either two or three phase induction motors, since a monocyclic generator connected to the primary circuit makes an excellent synchronous speed without the assistance of a starting motor, in this particular being vastly superior to the pure single phase synchronous machine. But, it may be asked, how about this power wire? In case, for example, of a transmission over a considerable distance before the distributing point is reached, must the power wire be part of the transmission system? In answer, I need only call your attention to the fact that the essential point of the monocyclic system, so far as motors are concerned, is the establishing of an E.M.F. bearing the same relation to the system as is borne by the teaser coil of the generator. Consequently, in case of a transmission plant, the main generators at the distant station may be simple single-phase machines, the subsidiary E.M.F. being furnished by a synchronous motor or similar device at any point in the system; so we might readily have an extensive transmission with a monocyclic machine in the sub-station of such size as is necessary to furnish current for what motors may be upon the system. The power wire would then run only to the sub-station. Another interesting peculiarity of the monocyclic system, and one which is not without importance in case of an extensive power distribution, is the following:

Under ordinary circumstances, induction and synchronous motors are wound so that the counter E.M.F. affects the system in a perfectly symmetrical manner, and the current flows over all the wires with some degree of symmetry in response to the demands of the motors on the system. It is customary, however, in the monocyclic system to employ motors so wound as to throw a high counter E.M.F. into the power wire when the motor is at speed and loaded, thereby reducing the normal current carried over the power wire to a purely nominal amount, and this can evidently be done without sacrificing much in the matter of starting, since at the start all the counter E.M.F.'s in the motors are zero. We have, then, a motor system of a type really peculiar to the monocyclic system, in that each motor will start under the same conditions of impressed E.M.F. as if it were a polyphase motor; while, when at speed and loaded, it would be operating virtually as a single-phase machine. If however, it were overloaded so that it would tend to slow down or stop, sufficient energy would flow over the power wire to bring it back to speed, just as if it were a polyphase machine. This is only one of various interesting ramifications in the system when developed to meet special conditions.

The connections shown in the diagrams, however, are those of the most direct applicability, and probably which would be most extensively used for central-station service. At this point it may be appropriate to ask: What is the disadvantage of such a system? It evidently secures exceedingly marked advantages in the ability to operate the lights on existing circuits or with the simplest possible kind of distribution, and at the same time to run at any point in the system synchronous or induction motors of well-tried and familiar types. The question can be readily answered; in fact, the question is almost obvious. The price which we have to pay for this advantage is the installation of the power wire, which necessarily adds something to the weight of copper in the system and to the trouble of installation. Under all ordinary circumstances the power wire needs to be of trivial cross section compared to that of the other wires, since, as a rule, the energy required for operating the motors from the given central station is small compared with the total capacity of the station; and, further, it is worth remarking that the monocyclic motors, either synchronous or induction, will run perfectly well if the power wire is disconnected after the motor is at a speed operating them as single-phase machines. It is, of course, well-known that the single-phase synchronous motor gives admirable results, and it is also true that a single-phase induction motor can be constructed of excellent efficiency and other electrical properties. The only material difficulty in this case is to get the motor to start with a good torque. The monocyclic connection enables this to be accomplished. After the motor is at speed the power wire becomes no longer necessary to successful operation, so that in spite of the necessary existence of the power wire it is easy to see that the additional amount of copper is not likely to be burdensome in central station operation. It would hardly ever be necessary to install a power wire of more than one-fourth the joint cross-section of the others, as given in the diagram, and generally a much smaller wire will suffice.

I have thus endeavoured in a brief space to give a good working idea of the monocyclic method of combined light and power distribution which has been devised and is urged upon the public as specially adapted for the work of central-station distribution on account of its unique simplicity in practice. As to what has already been done in the installation of such apparatus, a considerable number of these monocyclic generators are in daily use in central stations, for the most part operating over circuits already established and displacing the higher frequency alternators which had been previously used. They are giving excellent results, and the operation of the motors, wherever employed, has been highly satisfactory.

IMPORTANT PATENT DECISION IN THE UNITED STATES.

LAMPS AND TELEPHONES FREE.

In our issue of the 8th inst. we recorded the decision of the United States Supreme Court at Washington in the Bate refrigerator case. The judgment then given affirms the doctrine of the United States Circuit Courts that the term of an American patent expires with that of the foreign patent expiring first, irrespective of the relative dates of domestic and foreign application for a patent on the same invention. Commenting on this decision the New York *Electrical Engineer* says:

The decision seems in no wise to touch the intrinsic merits of Section 4,887—a piece of legislation that has justly incurred the disapproval of the best minds among patent lawyers of distinction (such as the late and lamented Grosvenor P. Lowrey) because of its obvious inequity. But Section 4,887 has now for a long period been uniformly interpreted by the Circuit Courts according to its obvious verbal significance, and vested interests with invested capital have long gone upon the assumption that the law was settled, and that they were secure in their reliance upon the general understanding of its scope and purpose. Now the Supreme Court confirms established rulings of the circuits, and whatever may be thought amiss is left for legislation by Congress. Such legislation, happily, cannot be *ex post facto*, nor invalidate the judgment of our highest tribunal.

While no judicious observer of the history of incandes-

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cent electric lighting will be disposed to minimise the honour due to Mr. Edison for his achievements, we feel well assured that both electrical experts and the general public will approve the final dissolution of the monopoly sought to be founded upon this questionable patent; while they will at the same time be likely to agree, for the most part, that Section 4,887 is an absurd provision, and that an American inventor who has applied for a domestic patent before he has applied for a foreign patent is merely unfortunate and not derelict if the foreign patent issues first.

From the point of view of electrical industry in general it is gratifying that the manufacture of incandescent lamps will be henceforth free, and that those firms and companies which, relying upon the long delay of the owners of the Edison patent in seeking to enforce their claims, as well as upon their confessed uncertainty as to the life of their patent, have gone into the business in good faith and have made good lamps, can now expand their work, assure adequate competition, and secure to themselves some reward for their efforts.

PHŒNIX FIRE OFFICE RULES FOR INSTALLATIONS OF ELECTRIC HEATING AND COOKING.

In our issue of March 8, in describing the electric radiators adopted at the Vaudeville Theatre, reference was made to the set of rules drawn up by Mr. Musgrave Heaphy, of the Phœnix Fire Office, for observance in cases where electric heating appliances are proposed to be installed. These rules, which will be applicable to future work of this kind, we are enabled to reproduce, by permission of Mr. Heaphy, together with the regulations to be observed in installations of electric cooking apparatus.

Electric Heating.

When any building or portion of a building is to be heated by electricity, the system and arrangements must be such as meet the approval of the technical adviser to the fire office. The same general electrical safeguards must be taken with regard to the installation as are required by the rules for an electric light installation, so far as they apply, but with the addition of such other safeguards as are stated here, or may be considered requisite by the technical adviser to the fire office. The same general safeguards for security from fire will be required with regard to the radiators, etc., that would be considered necessary by the fire office if the radiators, instead of being heated by electricity, were heated to a like temperature by other means. No electrical radiator to be heated to a higher temperature than would be allowed by the fire office for other kinds of heating apparatus.

All radiators must be fixed at such safe distance from woodwork and other combustible substances as may be required by the fire office. No radiator to be fixed in roofs, or in any position or place that may be objected to. Every radiator should be protected by its own separate cut-outs. All radiators should be fixed to, or stand upon, approved fireproof insulators. All sockets and plugs should be incombustible; they must be to the approval of the technical adviser to the fire office. No sockets will be allowed in any place nor in any risk that he may consider undesirable. The use of floor sockets is not desirable; when they are employed, the connections must be sweated into thimbles, they must be efficiently protected against mechanical injury, from damp, and other injurious influences. Every socket should be so constructed that the contacts are automatically covered when the plug is removed.

The main conductors, and all principal branches, must have a switch and cut-out on each conductor. The conductors for supplying current to the radiators must be attached to proper terminals of large carrying capacity. No conductor to be unencased without permission. The insulation upon any unencased conductor must be of special character, and have very strong coverings. No conductors to be so placed that they will be exposed to mechanical injury or to undue heat from the radiators. All work and materials to be of the highest character, and to the satisfaction of the technical adviser to the fire office. The entire installation (including the insulation resistance of the whole work, both with regard to earth and between conductors) must also be to his satisfaction. With regard to hazardous risks other special precautions may be required; these, of course, may vary according to the nature and circumstances of the particular risk. In hazardous risks, the electric heating installation should be distinct from any electric light installation that may be on the premises. Before commencing any work, therefore, in a hazardous risk, enquiry should be made at the fire office and their permission first obtained.

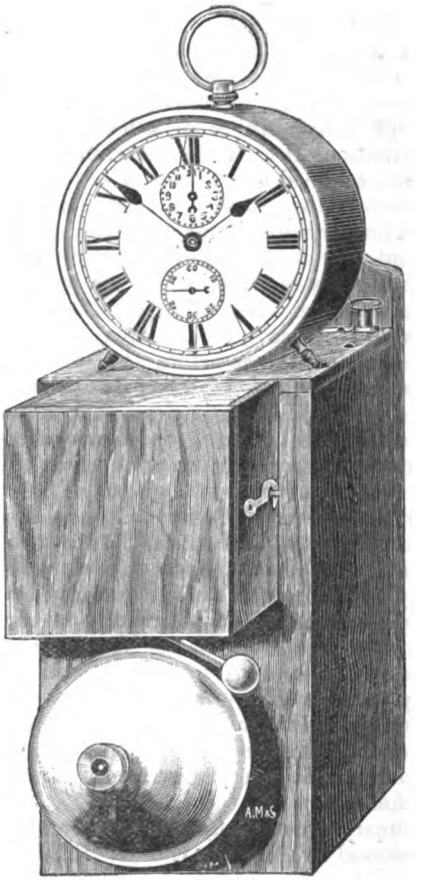
Electric Cooking.

The same general rules must be observed as for electric heating, so far as they apply. Every oven, stove, or other apparatus should be protected by its own separate cut-outs. The greatest care must be exercised in arranging the conductors that there is no possibility of any of them becoming unduly heated, either by proximity or contact with any of the apparatus, or from other causes. Care must also be taken that none of the electrical work is liable to mechanical injury. Special care must be taken with regard to insulation. This refers not only to the installation generally, but to the cooking apparatus itself.

With regard to the cooking apparatus, the same general safeguards must be taken with regard to security from danger of fire that would be considered necessary by the fire office if the apparatus were heated to similar temperatures by other means, and this applies also to the positions of the apparatus, methods of fixing, distance from and protection of woodwork or other combustible materials, etc. The whole of the work to be to the satisfaction of the technical adviser to the fire office.

"XL" ELECTRIC ALARM CLOCK.

The annexed illustration shows the "XL" electric alarm clock which has been placed on the market by Messrs. A. Mayer and Son, of 127, Aldersgate-street, E.C. The



clock is simple in action and use, and may be connected to any existing bell installation. It can be operated either by an E. S. dry battery or a Leclanché cell, and is claimed to be the cheapest obtainable.

LONDON COUNTY COUNCIL COMMITTEES.

PASTE THIS UP FOR REFERENCE.

We give below the names of the members of the Finance, Highways, and Works Committees of the London County Council, appointed on Tuesday.

First comes the Finance Committee, who will be remembered particularly by local authorities in the Metropolis in regard to recommendations concerning the periods under which loans for electric lighting purposes will be granted.

London electric supply companies, and local authorities having their own electric light stations, will bear in mind the Highways Committee in connection with the restrictions imposed in the past in regard to the laying of underground mains and the construction of transformer-chambers. But with Earl Russell and Mr. W. Haydon as members of the new committee, it is to be hoped that the latter will be taught how to act more sensibly than in the past.

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The Works Committee is fortunate in having the company of Mr. Harry Marks, who will be remembered as one of the most formidable opponents of the old Metropolitan Board of Works, and who is credited with having brought about the collapse of that body May the Works Committee be given a few lessons by the new blood just introduced.

The committees are composed as follows:

Finance Committee.—W. H. Bruce, C. H. Campbell, B. L. Cohen, Sir J. C. Dimsdale, Sir H. B. T. Farquhar, C. Harrison, S. B. Heward, A. Hoare, Hon. E. Hubbard, Sir John Hutton, Sir J. Lubbock, E. Spicer, Lord Welby, Sir A. Wilson, T. McKinnon Wood.

Highways Committee.—J. A. Baker, B. Cooper, T. L. Corbett, P. F. C. Costelloe, J. S. Fletcher, W. Haydon, N. W. Hubbard, Edwin Jones, Earl of Onslow, T. Reed, Earl Russell, W. C. Steadman, J. Thornton, T. B. Westacott.

Works Committee.—R. C. Antrobus, G. Bicker-Caarten, J. Burns, T. Catmur, J. Dixon, E. B. Ellice-Clark, W. H. Fox, W. Goodman, E. A. Goulding, A. Hoare, Hon. L. R. Holland, A. Humphrey, Robert Lyon, H. H. Marks, Viscount Mountmorres, W. C. Steadman, H. R. Taylor, J. Thornton, H. Ward, E. White.

LEGAL INTELLIGENCE.

EISLER v. MARSHALL AND ANOTHER.

This action, which was heard before Mr. Justice Matthew without a jury in the Queen's Bench Division last week, was brought to recover damages from the defendant for having failed to underwrite shares in the Scottish House-to-House Electricity Company, Limited, pursuant to an agreement of August, 1892, made between them and the plaintiff. The agreement provided that, in consideration of the plaintiff taking 2,000 £5 shares in the company, the defendants, by themselves or others, undertook to take and pay for 4,000 shares in the company on or before October 31, 1892, and that a penalty of £500 was to be paid by way of damages by the party failing to perform his part of the agreement to the party performing his. On October 31, 1892, no shares had been applied for. On December 15, 1892, the company was advertised, a prospectus issued, and the plaintiff sent in his application for 2,000 shares. On December 23, 1892, the plaintiff withdrew his application before allotment. He then went to Scotland to see the directors and Mr. M'Leod, the promoter of the Company. The result of that was that the plaintiff sanctioned the Company going to allotment and renewed his application, and had allotted to him 2,000 shares, upon which he paid £955. No money was forthcoming from the defendants, who failed to get the shares underwritten, and the Company was abandoned. The plaintiff thereupon commenced an action for rescission of his contract to take shares, which ended in a compromise, the plaintiff being freed from further liability in respect of them. He then commenced his action against the defendants to recover £1,000 damages under the agreement of August, 1892. It was contended on the part of the defendants that the date fixed for carrying out the agreement was October 31, 1892, and that the plaintiff had put an end to the agreement by cancelling his application for shares.

Mr. Justice Mathew, in giving judgment, said the question was whether the contract of August, 1892, was restored or revived by either party having waved any of its terms. That was a question of fact. The defendants were to provide £10,000 each by October 31 to pay the contractors of the company. The date came and went and nothing had been done. The company had been formed only in the sense that it had been registered, but no prospectus had been issued. At the end of October it was not possible for any of the parties to carry out the agreement. The plaintiff was convinced that things would not do and withdrew his application for an allotment. The plaintiff saw the directors, and it was said it was not right to go to allotment. The promoter then told plaintiff that he could provide £10,000 within a week, and upon that the plaintiff sanctioned the company going to allotment. The plaintiff had no right to call upon the defendants to subscribe for shares. The action was misconceived and had failed, and there must be judgment for the defendants, with costs.

COMPANIES' MEETINGS AND REPORTS.

SCARBOROUGH ELECTRIC SUPPLY COMPANY, LIMITED.

The third ordinary general meeting was held at Scarborough on Tuesday, Mr. G. Alderson Smith, the chairman, presiding.

The **Chairman** moved the adoption of the report and statement of accounts, which recommended that the credit balance of £418 on revenue account be carried forward. The report was, he considered, extremely satisfactory, considering that this was the Company's first year's work. During the first six months of the Company's operations, they worked at a loss month by month; but in the second six months they not only cancelled that loss, but earned the profit stated. There was a steady progression towards a dividend which could not be far distant. They had spent £5,385 additional on capital account during the year, including buildings £822, mains £2,808, transformers £1,033, and meters £563; and, as to the future, they were committed to the establishment of a new alternator at a cost of £750, the erection of a foreman's cottage, and the conversion of a super-heater into an economiser. It appeared advisable for the proper extension of the Company to seek the introduction of new capital, which, he imagined, would easily be forthcoming. They had now 7¼ miles of mains, which constituted one of their heaviest charges, but they were bound to go on progressing in this direction.

Mr. John Bell Simpson seconded the motion, speaking hopefully of the prospects of the Company, and declaring that in 10 years' time the electric light companies would be supplying most of the illuminating power in use.

In reply to **Mr. J. Sinfield**, **Mr. A. A. Campbell Swinton**, managing director, said that the Company had commenced with a charge of 7d. per Board of Trade unit, whereas some small companies charged 8d. or 9d. At present the charges made by the Scarborough company varied according to the quantity consumed, the different rates being 6½d., 6¼., 6d., and 5¾d., and in addition to that 5 per cent. discount was allowed for cash. He believed those were the lowest prices known, excepting at Newcastle-on-Tyne, and in the case of consumers of thousands of pounds' worth by certain large establishments in London. They were certainly lower than those of any company of the same size. The cost of production during the year had been: coal, 1·87d.; oil, waste, and stores, ·3d.; wages, 1·57d.; repairs, ·47d.; rents, taxes, insurance, ·19d.; salaries and other expenses, ·44d.; total, 4·87d., or nearly 5d. per unit, which was sold at an average price of 6d. That did not leave a very wide margin of profit, but the cost would not increase *pro ratio* with the output, so that, with an increased consumption, the profit would be more than correspondingly large.

The report was adopted. Mr. John Dale, Mr. John Bell Simpson, and Mr. J. W. Woodall, retiring directors, were re-elected.

BRITISH INSULATED WIRE COMPANY, LIMITED.

The ordinary general meeting of this Company was held at the offices of the Company, in Prescot, on the 13th inst., Mr. W. Harriner Brigg presiding over a good attendance of shareholders.

The directors in their fourth annual report and balance-sheet stated that the amount of the net profit, including the balance of £363. 14s. 4d. from last year, was £5,751. 2s. 9d., after writing off £3,500 balance of formation expenses, and making a liberal allowance for depreciation of buildings, machinery, patents, etc.

The directors recommended a dividend of 7 per cent. on the ordinary shares, absorbing £5,067. 12s. 8d. (a dividend of 7 per cent. on the preference shares having already been paid to December 31 last), leaving a balance of £683. 10s. 1d. to be carried forward to next year.

During the year the turnover of the Company has more than doubled, and the Company now numbers amongst its customers a large proportion of the principal cities and towns, and some of the chief railway companies in the kingdom.

The report was adopted, and Mr. Thos. Snape, M.P., having been elected a director, the meeting terminated with the usual vote of thanks to the chairman.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED.

Directors: Sydney Gedge, Esq., chairman; Major-General Geo. Hutchinson, C.E., C.S.I.; Frederick Newton, Esq.; R. J. Jenkins, Esq., C.E.; the Hon. Randolph Stewart; George Sutton, Esq, managing-director.

Report of the directors to be presented to the shareholders at the ordinary general meeting to be held at the Company's offices on Friday, March 22, 1895, at 12.30 p.m.

The annexed accounts show that a net profit has been made of £16,455. 13s. 11d. After payment of interest and income-tax, making allowance for depreciation of plant and the expenses of issuing the 4½ per cent. mortgage debenture stock, there remains £11,819. 8s. 3d., to which must be added £5,187. 14s. 2d. brought forward from last year. Deducting £1,050, the half-year's dividend on preference shares paid in October last, there remains at disposal a balance of £15,957. 2s. 5d. The directors have added £2,180. 9s. 2d. to the reserve fund, and they propose the payment of a further half-year's dividend on the preference shares at the rate of 7 per cent. per annum, and a dividend for the year at the rate of 6 per cent. free of income-tax, on the ordinary shares; these payments together absorb £5,152. 4s., and leave a balance of £8,624. 9s. 3d. to be carried forward. In the month of August last, an issue was made of £50,000 4½ per cent. mortgage debenture stock. The whole amount has been issued and the proceeds applied to paying off all existing mortgages and debentures, and to providing additional buildings, plant, and working capital. All expenses in connection with the issue of this new stock have been charged against the revenue of the year. The Company has not had during the year a single large contract for submarine cables, but the large increase in its general business has enabled a dividend to be paid of 6 per cent. instead of 5 per cent. as heretofore. The directors heartily congratulate the shareholders on this result and on the general satisfactory position of the Company. The directors who retire on this occasion, in accordance with the provisions of the articles of association, are Mr. R. J. Jenkins, C.E., and the Hon. Randolph Stewart, who, being eligible, offer themselves for re-election. The auditors, Messrs. Ball, Baker, Deed, Cornish, and Co., retire, and, being eligible, offer themselves for re-election.

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BALANCE-SHEET, DEC. 31, 1894.

Dr. Liabilities.	£	s.	d.
Authorised share capital—			
7,000 ordinary shares of £10 each	70,000	0	0
3,000 preference shares of 10 each	30,000	0	0
	£100,000	0	0
Share capital issued—			
6,837 ordinary shares of £10 each... £68,370 0 0			
3,000 preference shares of £10 each 30,000 0 0			
	98,370	0	0
4½ per cent. mortgage debenture stock	44,500	0	0
Creditors on trade accounts 26,730 1 6			
Unclaimed dividends..... 67 10 0			
	26,797	11	6
Contingent liability in respect of bills discounted £2,680 9 5			
Reserve under cable repairing contract	2,450	5	8
Profit and loss account—proposed amount to be apportioned to dividends—			
On ordinary shares at 6 per cent. 4,102 4 0			
On preference shares at 7 per cent. 1,050 0 0			
	5,152	4	0
Balance to be carried forward .. 8,624 9 3			
	13,776	13	3
	£185,894	10	5

Note.—100 shares of £10 each, fully paid, appear in this balance sheet *per contra*.

Cr. Assets.	£	s.	d.
Property consisting of freehold land, buildings, machinery, plant, and goodwill	107,390	0	2
Shares held in International Cable Company, Limited, £48,200; less reserve against these shares, 48,20000	—		
Debentures and shares held in other companies, £4,894. 1s. 6d., and ordinary shares held by the Company, £1,000	5,894	1	6
Stock in trade, including expenditure on orders in hand	38,231	11	11
Debtors, after making provision for bad and doubtful debts	25,148	9	5
Bills receivable in hand	3,109	0	1
Cash at bankers and in hand	6,121	7	4
	£185,894	10	5

PROFIT AND LOSS ACCOUNT YEAR ENDING DEC. 31, 1894.

Dr.	£	s.	d.
Directors' remuneration, salaries, rent of offices, maintenance of works, general expenses, etc. ...	10,002	5	6
Bad and doubtful debts	860	14	4
Balance carried down	16,455	13	11
	£27,318	13	9
Interest on mortgage and debentures	1,960	17	9
Depreciation of machinery, etc.	1,000	0	0
Income tax	587	13	2
Reserve account—further amount charged to fully provide for International Cable Company's shares	2,180	9	2
Expenses in issuing 4½ per cent. mortgage debenture stock and redemption of old mortgage and A and B debentures	1,087	14	9
Half-year's dividend at rate of 7 per cent. per annum on preference shares, paid on October 1, 1894 ... £1,050 0 0			
Proposed half-year's dividend on ditto at rate of 7 per cent. per annum 1,050 0 0			
Proposed 6 per cent. dividend on the ordinary shares, free of income tax 4,102 4 0			
	6,202	4	0
Balance to be carried forward	8,624	9	3
	£21,643	8	1

Cr.	£	s.	d.
Gross profit on trading, including rents of cottages, etc.	27,318	13	9
	£27,318	13	9
Balance brought down	16,455	13	11
Amount brought forward from 1893	5,187	14	2
	£21,643	8	1

ROCKHAMPTON GAS AND COKE COMPANY, LIMITED.

We have received a copy of the report and accounts of the directors of this Queensland Company for the half-year ended December 31, 1894. The report, which was presented to a meeting of the shareholders on the 7th ult., is given in abstract below.

The directors are able to report an improvement upon the preceding half year, due to an increased demand for the electric current and to the reduced expenses in connection with the electrical operations. The rigid economy practised by the townspeople in their gaslighting has naturally had a marked effect upon the gas consumption for the half-year, and although the number of customers continues to increase, the total consumption is considerably lower than in former years. With more prosperous times and the ordinary development of the town the directors expect to see a recurrence to the freer demand for gas. The gas operations show a profit of £1,672. 2s. The electrical operations show a profit for the half-year of £183. 6s. 2d., which has gone towards the payment of the £300 interest upon the whole of the Company's debentures charged to the electric light operations, leaving a difference of £116. 13s. 10d. represented in the debit balance of the profit and loss account of this section of the Company's business. The net profit for the whole of the Company's business is £1,555. 8s. 2d.

During the half-year premiums amounting to £465 have been received from new shares, and this profit has, in accordance with the usual custom, been placed direct to the credit of the reserve fund for the equalisation of dividends, which now stands at £574. 5s. 10d. As the Company has as much money as it requires at present, the directors thought it advisable for the time being to stop the sale of the new shares, to prevent an accumulation of capital which would only be earning the present small bank interest and which would represent a loss of the difference between the rate allowed by the bank and the dividend paid by the Company to the shareholders. The directors recommend the appropriation of £293. 3s. 6d. from the reserve fund for the equalisation of dividends, to permit of the payment of a dividend at the rate of 8 per cent. per annum upon the ordinary shares, and 9 per cent. per annum upon the preference shares, amounting to £1,848. 11s. 8d., free of dividend tax. The large demand for coke and tar continues, and it is satisfactory to know that the stocks of these two articles are consequently low. The whole of the general reserve fund, amounting to £2,898. 17s. 2d., is now invested as a fixed deposit with the Bank of Australasia. This fund is in future to be devoted exclusively to the maintenance and improvement of the Company's plant. The prospects of the Company are bright, and justify the directors in anticipating an encouraging development in the Company's operations, and to ensure this, strenuous efforts are being used to keep down expenses. The agreement between the electrical engineer and the Company terminated in October last. Another electrical engineer to take his place is now on his way out in the s.s. "Ophir."

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Brazil.—The Municipal Council of S. Joao d'El Rey, Minas Geraes, are asking for tenders for lighting the town by electricity.

St. Pancras.—Particulars are given in our advertisement columns of tenders required by the St. Pancras Vestry for the construction of a sub-station.

Norwich.—The Town Council require by April 2 tenders for the supply of two Galloway boilers and the installation of electric light fittings at the new baths.

Stowmarket.—The Urban District Council require by April 15 tenders for lighting the streets of Stowmarket from August 15 next to May 15, 1896, and also for lighting the post office clock. Particulars may be had of Mr. S. Prentice, clerk.

Bradford.—The Corporation require tenders by the 28th inst. for the construction and delivery of two steam dynamos. Specification may be had on application to Mr. Baynes, Electricity Department, Town Hall, Bradford, on payment of £1. 1s.

West Ham.—The Town Council require by the 26th inst. tenders for the supply of a 12 h.p. nom. portable steam-engine. Specification and further particulars may be obtained of Mr. Lewis Angell, borough engineer, Town Hall, Stratford, E., on payment of £1.

Llanelly.—The Borough District Council desire by the 25th inst. plans, designs, specifications, and estimates of cost for the supply and installation of electrical plant and machinery, including street lamps and laying down mains. Plans of the district can be obtained from Mr. George Watkeys, C.E., borough surveyor, Llanelly.

Nottingham.—The Corporation invite by the 28th inst. tenders for two Lancashire steel boilers (26ft. long and 7ft. diameter) and fittings, and placing same on their seats at the public baths, Sneinton. Plans may be seen and copies of the specification obtained at the office of Mr. Arthur Brown, M.I.C.E., borough engineer, on payment of £2. 2s.

Worcester.—The Corporation invite tenders by April 6 for wiring Victoria Institute. Copies of specification may be obtained from the architects, Messrs. Simpson and Milner-Allen, 10, New-inn, Strand, London, W.C., accompanied by a deposit of £1. 1s. Plans of the lighting system may be seen at their offices, and on the works. Tenders are to be delivered at the offices of the architects.

Madrid.—The Electricity Supply Company for Spain, Limited, invite tenders for the supply and erection of certain machinery, etc., for the extension of their electricity works in Madrid. The plan of buildings and statement of requirements, with terms and conditions of tender, may be obtained at the office of the company, 15, St. Helen's-place, London, E.C., or of Mr. Robert Hammond, the consulting engineer, Ormonde House, Great Trinity-lane, London, E.C., on payment of £1. 1s. Tenders must be addressed to Mr. P. A. Latham, secretary, by the 27th inst.

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RESULTS OF TENDERS.

Yarmouth.—The Town Council have accepted the tender of Messrs. Crompton and Co. for 40 joint boxes at £1. 17s. 6d. per box.

Birmingham.—The Town Council have accepted the tender of Messrs. D. and G. Graham, of Glasgow, for the supply of electrical plant for the new technical school.

Hanley.—The Town Council have accepted, at £4,036, the tender of Messrs. S. Z. de Ferranti, Limited, for the supply of additional generating plant at the central station.

Brentford.—The tender of Messrs. Harrison, Coles, and Co., of Richmond, has been accepted, at £131. 10s., for supplying and fixing telephones and electric calls in connection with the fire brigade, for the Urban District Council, and at £100 for maintenance for 10 years.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—The receipts for the past week were £3,605.

Croydon.—The Chamber of Commerce are investigating the question as to the probable demand for light in the compulsory area.

Halifax.—The electric light is to be adopted in the new police offices and court-house to be formed of the existing infirmary buildings.

Folkestone.—It is stated that the Dover Electric Supply Company are prepared to transmit electrical energy for the lighting of Folkestone.

Chelsea Electricity Supply Company, Limited.—Letters of allotment and regret for the issue of 4½ per cent. debenture stock have been posted.

Wimbledon.—Messrs. Drake and Gorham have been successful in obtaining the contract for the electric lighting of Mr. Bishop's new house, Wimbledon.

Electric Construction Company.—The registered address of the Electric Construction Company, Limited, is now Dashwood House, 9, Old Broad-street, E.C.

Medical Electrical Institute.—In this case Mr. Justice Vaughan Williams on Wednesday made a compulsory order, on the petition of James Willing the younger.

Morecambe.—The Urban District Council have approved of the plans of the Morecambe Electric Light and Power Company for the erection of a new generating station in Moss-lane.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 17th inst. amounted to £975, as compared with £707 in the corresponding week of last year.

Payment of Coupons.—The Bank of Montreal will pay on the 1st prox. the coupons then due of the 4½ per cent. debenture loan for £120,000 of the Royal Electric Company of Montreal.

Yarmouth.—The Town Council have appointed Mr. A. W. Ranken, who has acted as clerk of works during the construction of the central station, electrical engineer at £175 per annum.

Hull.—The Electric Lighting Committee of the Corporation think that another boiler and engine should be installed for meeting the anticipated increase in the demand by next winter.

Chemical Syndicate.—The Chemical Syndicate, Limited, has been formed, with a nominal capital of £6,000, for the purpose of acquiring a new process for manufacturing cyanide of potassium.

Whitehaven.—It was mentioned to the Town Council last week that the two new engines and dynamos ordered by the late Board were now in position, and that within a fortnight they would be at work.

Southend.—The Town Council having resolved to try incandescent gas lamps in several parts of the borough, have also appointed a committee to consider the desirability of installing the electric light.

Dover.—The supply of the electric light from the company's station is shortly to be commenced, and it is expected that the lighting of the sea-front by means of arc lamps will be completed by Easter.

Birmingham Central Tramways Company.—An order has been made by Mr. Justice Stirling confirming a special resolution of the Birmingham Central Tramways Company, Limited, for the reduction of its capital.

Worcester.—The Board of Guardians have authorised Mr. Rowe, architect, to prepare specifications for the lighting of the male ward block and workshops by electricity, and to obtain tenders for carrying out the work.

Liverpool.—The Lighting (Special) Committee of the Corporation met on Monday to again consider the proposed purchase of the Electric Supply Company's undertaking. The matter was again deferred for further consideration.

City and South London Railway.—The receipts of the Company for the week ended March 17 were £912, against £926 for the corresponding week of 1894, or a decrease of £14. The total receipts for the current period of the present half-year are £10,823, against £10,400 in the corresponding period of 1894, an increase of £423.

Sale of Electrical Plant.—As will be seen by our advertisement columns, Messrs. Percy Huddleston and Co. will sell by public auction on Tuesday and Wednesday next the stock of a cable manufacturer and electrical engineer at Dawson's, Croft Mill, Greengate, Salford.

Conway.—The Town Council last week had under consideration an application from the electric tramway company for permission to extend their proposed line from Deganwy by way of the Morfa to Conway. It was agreed to give assent to the scheme, subject to certain conditions.

Moss Side.—The Finance Committee having found that there is only a sum of about £240, after allowing for all contingencies, to provide electric lighting for the Princess-road Schools, the School Board have resolved that in view of this fact the electric lighting scheme be abandoned.

Heywood.—The gas manager last week presented a report on electric lighting to the Gas Committee. In reply to a member, Alderman Firth (the chairman of the Gas Committee) said that enquiries had been made, but as yet the committee could not recommend electric lighting for Heywood.

Direct Spanish Telegraph Company.—The directors have decided to recommend the payment of a dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend, free of income tax, at the rate of 4 per cent. per annum on the ordinary shares for the half-year ended December 31 last.

Wakefield.—Some months ago between £700 and £800 was expended in the renovation and enlargement of the large organ at the Cathedral. A further improvement is now contemplated, and Mr. Speight, of Leeds, has been requested to send in an estimate of the cost of a new blowing apparatus by hydraulic or other means.

Newmarket.—The Urban District Council have received a letter from the Board of Trade notifying that the electric light company have not taken up their powers of introducing the light into the town, and that they proposed to revoke the order. The Council passed a resolution that they would be glad to have the order revoked.

Private Lighting.—The electric light is being installed in Archbishop's House, Westminster. The work has been entrusted to Mr. Frederic Berlyn, of Messrs. Roger Dawson, Limited, of 63, Berners-street, London. A feature of this installation will be an ingenious arrangement of switches, by which a considerable saving will be effected over gas in this spacious building.

Dublin.—Referring to the note in our last issue concerning the reconstruction of the Southern District Tramway Company's line, the British Insulated Wire Company, of Prescot, inform us that they have obtained the order for the whole of the high-pressure triple concentric cables for the tramway, being 11½ miles in length, and suited for working at 2,500 volts with triphase current.

Monmouth.—The Town Council on Monday accepted the revised portion of Mr. Lailey's plans, etc., for drainage within the borough. The total estimated cost of drainage and electric light is £18,537. It was resolved to apply to the Local Government Board for power to borrow £20,000 for the purpose of carrying out the combined scheme and paying off preliminary expenses already incurred.

Cleckheaton.—The subscribers to the National Telephone Company in Cleckheaton were notified on Wednesday that the directors of the company had decided that Cleckheaton shall be a joint area, as between Bradford and Dewsbury, and that the Cleckheaton subscribers may have the option of electing to be in either the Bradford or Dewsbury area, free connection being granted in the chosen area. The arrangement is to come into force on the 1st prox.

Marshall v. the South Staffordshire Tramways.—The arguments in this appeal from the decision of Mr. Justice Kekewich were resumed on Wednesday before Lord Halsbury and Lords Justices Lindley and Smith. The important point raised is whether the holders of mortgage debentures issued by a tramway company are in the same position as the holders of mortgage debentures issued by a railway company. Their Lordships took time to consider their judgment.

Scarborough.—During the past year the Scarborough Electric Supply Company have supplied electrical energy to the amount of 89,727 Board of Trade units at a gross revenue, including meter rent of £2,277. There is a net balance of £418, which the directors consider a satisfactory result on the first year's working. They propose carrying this amount forward. Mr. G. Alderson-Smith has been elected chairman of the company, vice Lieutenant-Colonel Steble, resigned, and Mr. J. E. Ellis, M.P., has been elected a director to fill the vacancy on the Board.

Damage to a Telegraph Cable.—Mr. Justice Day and Trinity Masters have found for the defendant shipowners in the action brought by the Direct Spanish Telegraph Company, Limited, against the owners of the ss. "Caloric," which, dragging her anchor in the Bay of Bilbao, when it was hove, was found entangled by two cables, one of which parted, and the other the ship's carpenter cut, The Court held that the master followed the common practice, and so was justified, and was not guilty of negligence in respect to the ground he selected for his anchorage.

Sunbury (Surrey.)—The Urban District Council have received a letter from the Local Government Board in reference to the land needed for the outfall sewerage works. Mr. Hyde mentioned at a meeting of the Council last week that he thought if they could get a better scheme they should pay £300 more to have the enquiry over again rather than pay £2,000 a year for the working expenses. He had been told of a scheme to deal with the sewage by electricity which would save the town £1,500 to £2,000 a year. It was a scheme formulated by Mr. South, of Staines. It was decided to hold a special meeting, at which Mr. South is to be invited to attend.

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Bristol.—The Sanitary Committee last week received a communication from the secretary of the Electrical Committee enclosing certain resolutions passed by the committee with reference to the proposed electric tramway at Old Market-street. The committee recommended the Sanitary Committee that it was not advisable to utilise the poles of the tramways company for arc lamps. They also recommended that the tramway posts be put at a distance of 12 yards from the arc-lamp posts. The third resolution stated that the committee were prepared to recommend a suitable person as clerk of the works.

Appointments Vacant.—An engineer is required at Mullingar Asylum. Candidates must be competent to take charge of the boilers, engines, dynamos, and general heating apparatus. The salary offered is £70 per anum, all found including clothing. Applications are to be sent to the medical superintendent, District Asylum, Mullingar, by 25th inst.—A clerk of works is required at once for the Bristol electric tramway. Only those experienced in tramway or railway work and having high references need apply. Applications are to be sent by letter to the Secretary, Bristol Tramways and Carriage Company, Limited, Bristol.

Leeds.—The town hall and municipal buildings are now lighted with electric light, supplied by the Yorkshire House to House Company. Hitherto the current used for this purpose has been produced by an engine and dynamo in the basement of the municipal buildings. On Saturday evening the work commenced of connecting the lights in the two buildings with the mains of the electric lighting company, and this was completed on Sunday evening. Afterwards the current was turned on. The Corporation are paying the company 4d. per unit for the supply, this being about the same as it had hitherto cost them to produce with their own plant.

Bury.—An enquiry was held on Wednesday by Mr. T. Coddrington, C.E., with reference to an application by the Corporation to borrow £3,000 for an enlargement of the destructor, and £30,000 for electric lighting purposes. The Town Clerk (Mr. Haslam) said that power to supply the electric light was obtained in 1890. It had been decided to adopt the direct-current low-pressure system. The borough surveyor (Mr. Cartwright) gave further particulars. He said there would be three engines, three dynamos, with accumulators, etc. They would be able to supply 12,000 lamps and leave room for extensions; but machinery for half that amount of light was only being put in now.

Recent Failure.—A statement has been issued by the Official Receiver under a receiving order granted on the 26th ult. against Mr. J. Lewis Young. It appears that by profession the debtor is an electrical engineer, and that he joined his brother in partnership in 1891 in an established business carried on at 60, Ludgate-hill, paying £400 for a half-share. The liabilities are returned in the accounts at £3,108, of which £2,958 appear to be unsecured, with available assets nil, debts to the amount of £620 being returned as bad. The debtor attributes his insolvency to stoppage of his businesses in consequence of actions brought against him for alleged infringement of patent rights, and a subsequent adverse verdict which involved him in heavy claims for law costs.

Macclesfield.—The Board of Guardians have received a letter from Mr. S. V. Clirehugh, of Manchester, stating that it was proposed by a syndicate, to which he was consulting engineer, to establish at Macclesfield a central station for the purpose of supplying electricity to certain public buildings in the vicinity. To that end the infirmary and Parkside Asylum had been approached. He wished to know whether they would be prepared to consider the question of taking a supply were such a station erected. The charge, he added, would be equivalent to gas at 2s. 6d. per 1,000. The cost of fitting the workhouse with necessary wires, etc., would be about 25s. per light. He asked for an interview with the object of enabling him to explain the scheme more fully. The letter has been referred to the House Committee to have an interview with the writer.

The City.—The Streets Committee of the City Commission of Sewers were asked on Tuesday by Mr. Wallace whether the Streets Committee would present a report shortly on the subject of the telephone tubes. Mr. Morton reminded his colleagues that the whole question had been referred to a Select Committee of the House of Commons and that it was hardly likely that the committee could present a report while the matter was *sub judice*. He regretted to know that the City was not represented on that committee, although he had done his best to get it represented. He considered that the City, which was primarily concerned, had been very badly treated. He thought, however, that the Streets Committee should make some representation to Parliament through the Remembrancer. The Streets Committee have instructed the Remembrancer to take some action in the matter.

Whitechapel, E.—The District Board on Monday had presented to them by the Streets Committee its long expected report on the question of lighting the district by electricity. Some three years ago the Board obtained a provisional order. With the help of Prof. Robinson three schemes have been prepared. The committee recommend the Board to light the compulsory area at an estimated outlay of £44,500. The central station will be at the destructor-yard. The matter was discussed shortly at the Board meeting on Monday and adjourned. Prof. Robinson has been appointed electrical engineer to the Board for the purpose of carrying out the work. The committee sent circulars to 89 of the largest ratepayers, asking them whether, in the event of the Board providing the electric light, they would be likely to use it. Forty-six replied in the affirmative, nine in the negative, nine were doubtful, and 25 did not reply.

Llandrindod.—The Urban District Council last week discussed the question of public lighting. The Chairman strongly advocated the adoption of the electric light. He had recently noticed little villages on the Continent with the electric light in the houses of the poor. It would be ridiculous to think of gas, particularly in a health resort. Mr. Jones was in favour of starting gasworks, and was of opinion that a small gas plant could be made to pay at once. The clerk read extracts from a report made in November, 1893, by Mr. Preece, of Bradford, upon the cost of lighting the district by electricity, and suggested that the Council should obtain a provisional order, and make an agreement with the company to construct the works and carry the scheme into effect. He saw no reason why the Council should not rid themselves of responsibility in this matter. The idea seemed to meet with general approval, and it was resolved to invite Mr. Preece to come down and address a ratepayer's meeting on the subject.

Southport.—The Southport Town Council met on Tuesday for the purpose of considering resolutions passed by the Electricity Committee to the effect that application be made to the Local Government Board for sanction to borrow £3,000 for street-lighting, and £6,000 for the purpose of extending the works. Councillor Hesford moved the adoption of the resolutions, and Councillor Todd seconded the motion. Alderman Griffiths was of opinion that the Electricity Committee were not wise in limiting themselves to £3,000 for arc lighting. If they were to lay a cable to the extent of this estimate it would only provide for 40 lamps. He was in favour of their borrowing a sufficient sum to meet all requirements for the next four or five years. Councillor Hulme thought Southport could have no better advertisement than that which would be afforded by the fact that their promenade and streets were lighted by electricity. Councillor Travis thought they ought to borrow £12,000 instead of £6,000, so that the Council could have it within its power to grant money to the Electricity Committee when need arose. Eventually, on the suggestion of Councillor Travis, Councillor Hesford moved that for street-lighting and the benefit of private consumers respectively, they ask for sanction to borrow £3,500 and £12,000. The resolutions were carried.

Hanley.—The Town Council on Tuesday adopted a report of the Electric Lighting Sub-Committee, who recommended that the street lamps should be charged at the rate of £16 per lamp per annum, and that the charge for the same during the past half-year should be £170. They further recommended that the borough surveyor (Mr. J. Lobley) and electrical engineer (Mr. Cottam) should provide in the scheme they are preparing for the extension of the mains, for cables being laid in Broad-street, Snow-hill, Howard-place, Stoke-road to the park, Hope-street, Etruria-road to Hanley Station, Clough-street, Market-street to Bath-street, Birch-terrace, Jasper-street, and Regent-road, and for street lighting only, the following roads on the Park Estate: Matlock-street, Harding-street, Outer Circle street, Cleveland-road, Victoria-road, Park-avenue, and Avenue-road. The committee also submitted a statement of accounts up to December 31, 1894, in connection with the electric light undertaking, which showed receipts £1,574 and expenditure £916, leaving a profit of £658, out of which £627 had been appropriated for interest, and £31 for the reserve fund. The committee also recommended that the tender of Messrs. S. Z. de Ferranti, Limited, for generating machinery at the electricity works, amounting to £4,036 be accepted, and that application be made to the Local Government Board for sanction to borrow £5,000, repayable in 25 years.

Hampstead.—The Electric Lighting Committee recommended the Vestry, last week, to employ their own engineer (Mr. Chattock) to superintend the carrying out of all future work in connection with electric lighting in the parish. Mr. Thwaites, chairman of the committee, formally moved the adoption of the recommendation, and Mr. Adams seconded the motion. Mr. Underwood moved, as an amendment, that the Vestry should employ Mr. Preece to carry out all future installations in the parish until the next election of vestrymen, and that his remuneration be 4 per cent. on the outlay. If the motion were carried, he remarked, the Vestry would be acting in as mean and shabby a manner as possible. Mr. Bence seconded the amendment. Mr. Ryalls stated that, including the hundred guineas received for the preparation of the scheme for lighting the parish, Mr. Preece had up to the present time received between £1,300 and £1,400. They could not be accused of shabby conduct in view of that fact. Mr. Thwaites said that when the installation reached 16,000 private lamps a profit would probably be shown. At present there were 6,194 lamps connected. The amendment was lost, only six members voting for it. Mr. Elliott then moved, and Mr. Reed seconded, that the recommendation be referred back to the committee, the latter remarking that Mr. Chattock had not yet been asked if he would undertake this new responsibility. This amendment was also lost, and the recommendation of the committee was adopted. The Vestry decided to ask Mr. Preece if he will act as consulting engineer to the Vestry until the next annual election of vestrymen.

Leicester.—The Town Council last week adopted a report bearing on the financial position of the electric lighting department. In moving the acceptance of the report, Alderman Lennard said that they had passed through the most trying stages—the initiatory stages of a new department—and at the end of that time they placed before the Council a balance-sheet which, after placing £130 to the reserve fund (practically profit), only showed a loss of £190 up to Christmas last. That amount the committee did not propose to take out of the rates, but to carry it over to next year. He believed that in the first year of complete working

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they would show a profit on the prices they now charged. The balance-sheet showed that they had raised the full amount authorised on capital account—namely, £42,748—but up to the present they had only spent £18,882 of that The total receipts on revenue account had been £382, and the gross profit £263. On the expenditure side of the account he would only refer to one item, that of the fuel, which came out at the low figure of £14 15s. This was due to the fact that the fuel they used was practically refuse, only a degree better than the absolute refuse which they used as fuel in the chemical department of the gasworks. As to the price for light, they were at present charging 6d. per unit, but the committee hoped that before 1895 ended they would be able to ask permission to reduce the charge to 5d. At present the highest demand on the department had been only one-sixth of their capacity, but the committee were satisfied that on the present price charged they were paying their way, and with an increased consumption they hoped to be able to reduce the price.

Fareham.—The electric lighting question was further discussed last week at an adjourned meeting of the Urban District Council. The point under consideration had reference to the letter received from Mr. Graham Whitlock, solicitor to the Fareham Electric Lighting Company, calling upon the Council to fulfil the contract to purchase the undertaking, made by the late Local Board, and so to avoid litigation. The Chairman said that on the 1st inst. a resolution was moved by himself and seconded by Mr. Etherington, that Mr. Whitlock's letter should lie on the table, and that this was under discussion when the Board adjourned. Mr. Abraham moved an amendment to the effect that counsel should be consulted as to the liability of the Council under the contract. Mr. Batchelor seconded the amendment. Mr. Blake said it would be much against the desire and the inclination of the Electric Light Company to go to law against the town of Fareham. Mr. Smith had said that his statement that the late Local Board agreed to purchase the undertaking of the company for £5,000 was untrue, but he would refer the Council to the minutes. He complained that the chairman had not asked the opinion of the clerk with regard to the contents of Mr. Whitlock's letter, adding that the business of the Board had been neglected in that respect. The Council would be bound to have counsel's opinion within the next 14 days, even if the amendment was not carried. Mr. Smith was of opinion that it was now too late to obtain counsel's opinion. The Local Board should have obtained it before the alleged contract was signed. The chairman having summed up, the amendment was put and rejected, and the resolution was declared carried.

Edinburgh.—The Lord Provost's Committee of the Town Council have had under consideration the motion by Councillor Douglas to consider and report whether any and if so what steps should be taken in the interest of public safety to secure that any faults in gas mains and service pipes shall be detected and removed without delay, and to provide against any dangers likely to result from insufficient piping in connection with the introduction of the electric light into the city. The committee have thought it advisable to refer the motion in the first place to the Electric Light Sub-Committee in order that a report may be made on the subject. The minutes of the Works Committee, presented to a meeting of the Edinburgh and Leith Commissioners on Monday, showed that the convener, Bailie Kinloch Anderson, with the engineers, had had a conference with the convener of the Electric Light Sub-Committee, Prof. Kennedy, Mr. Monkhouse, and the Town Clerk, on the subject of electric light and gas escapes. After full discussion, it had been arranged that the Electric Light Sub-Committee should adopt certain further precautions for the prevention of explosions—the Gas Commissioners, on the other hand, undertaking to continue their present methods for discovering and remedying escapes. Councillor Waterston said it would be well if the convener of the Works Committee were to state precisely what precautions had been taken to prevent a recurrence of the explosions. Bailie Kinloch Anderson said he did not think that the public required to be instructed as to the precautionary methods adopted if they had the assurance of the Commissioners that the utmost precautions were being taken for the public safety. The commission was directly interested in the matter, because if gas was escaping they lost money. It was therefore their interest to detect escapes at once, and both the electrical engineers and their own engineers were at one in the opinion that the further precautions to be taken would be sufficient to meet the case. The steps that the electrical engineers were to take would prevent the accumulation of gas in the culverts in any large quantity, and the precautions that the Commissioners' engineers had adopted would obviate the risk of any further explosions.

Birmingham.—The question of accepting a tender for the electric lighting of the new technical school, to which we have referred in previous issues, again came up for consideration at a meeting of the Town Council on Tuesday, when Mr. Martineau presented the report of the Technical School Committee, and moved that the committee should be empowered to expend £6,080 in providing electric light fittings and motive power at the new technical school. Since the proceedings at the last Council meeting, Mr. Martineau said the committee had again reconsidered the matter, but having on a former occasion given the most attentive, conscientious, and deliberate consideration to the subject, they found they were unable to come to any other conclusion than that which was before the Council. Alderman Johnson seconded the motion. Mr. Bradley moved as an amendment that the following rider be added: "That the committee be and are hereby instructed to accept the lowest tender submitted under specifications originally issued to a select number of firms." That, he said, was the third attempt on his part to prevent the Council from deliberately sanctioning what he regarded as an injustice. He contended that the second specifications ought not to have been issued. If any amendments were required upon the original tender they could have been made by arrangement. He thought the committee had made a dead set against a particular firm, and he did not think it right that the Council should have either to sanction a wrong or accept the resignation of the committee. Mr. Bishop seconded the amendment. Alderman Parker, in defending the action of the committee, pointed out that the original tenders were made on the condition that the committee were not bound to accept the lowest or any of them. Fresh specifications were thought desirable. Tenders were invited, and Messrs. Fowler, in tendering again, actually acquiesced in the principle of discarding the previous tenders, which were really dead. In the second contract they were above many of the firms in the trade, and if there was any injustice it would be in accepting one of the higher tenders in the second competition. Those below Messrs. Fowler would then have real cause for complaint. Mr. Reynolds and Mr. Parkes both supported the resolution of the committee, the latter gentleman protesting against Mr. Bradley's assertion that the committee made a dead set against any firm. Mr. Coombs contended that the committee had acted in the truest and highest interests of the City, and he thought they were entitled to the consideration of the Council in the matter. Mr. Bisseker said that if any member wanted to see where the specifications had been changed, he should be delighted to show them. The principal part of the change was made in the fittings for the engineers' department, which had been condemned as impracticable by Dr. Sumpner, the new professor, and several other experts to whom he had submitted them. He argued that the committee had a perfect right to alter any specification they chose, inasmuch as the matter had not been voted upon in the Council. It was better to amend the matter in committee than to have it brought up in the Council and sent back to the committee for revision. The vote was then taken, and 17 were in favour of the amendment, whilst there were 35 against it, and one member remained neutral. The amendment was therefore lost, and the original resolution was carried. The report was afterwards approved.

Cardiff.—The Lighting Committee of the Town Council had presented to them on Tuesday two reports on the electric lighting of the town. Mr. W. H. Massey, the consulting engineer, stated in his report that the private lighting had given great satisfaction since the current was first turned on, and as he understood that applications for the light were steadily coming in, they might soon expect an increased load for one of the large engines and dynamos. On the last occasion of his visiting the Cardiff works, on the night of the 8th inst., the maximum load, including the arc lighting, was not quite equal to one-half of the full capacity of the one set of machinery, and the average throughout the run did not exceed one-third of that capacity. Deducting the portion due to the arc lighting, the average amount of current supplied to private consumers between 4 p.m. and 12 midnight was only equivalent to that required for about 600 40-watt (so-called 8 c.p.) lamps, whilst the greater number of lamps in use during a comparatively short period that evening scarcely reached 1,200. Under those somewhat unfavourable conditions the engines continued to work well and very economically, too, if the figures he saw relating to coal consumption, etc., were accurate. He hoped before long, when the machinery was fairly loaded, to have an opportunity of making some efficiency tests, of which the committee should have full details. Mr. Massey went on to say that the street-lighting had not been so successful, but the nature and extent of the failures since January 1 had been very grossly exaggerated, and the mishaps were generally due to shortcomings elsewhere, and not in the system of rectifiers introduced in Cardiff. The lamps were placed alternately, and the failure of one half of the entire system would still leave the streets fairly well lighted. The contractors were now fitting improved automatic cut-outs to each lamp, and when the defect in the governor and regulating gear of the engines had been remedied, Cardiff would have a very perfect system of street-lighting. With regard to what steps were necessary to carry out and perfect the system, it would be necessary to provide a supply of current for private consumers during the whole 24 hours, and the two small compound engines and dynamos might have been used for that purpose during the past four or five months. Mr. W. Harpur, the borough engineer, in his report stated that he could not give sufficient reason for the long delays in delivering the different parts of the machinery, the only excuse which he had heard adduced being the prolonged coal strike, which prevented the making of the iron, etc., requisite for the manufacture of the machinery. He believed, however, that the committee would have done wisely, and a great deal of time would have been saved, had they taken his advice and appointed a competent person to have superintended on their behalf the erection of the plant. With regard to the present condition of the plant, all the machinery, etc., contracted for in the original contracts had been delivered, and had been running and supplying energy to private consumers since November 17 last. A few more small accessories were still necessary for the efficient working of the station. The plant being in one or two respects novel for electric lighting purposes, experiments were necessary for proving its adaptability to their requirements. The condenser had given trouble from time to time, and some difficulty had also been experienced in getting the rectifiers to run properly, and even at the present time they were not running satisfactorily on the compound engines. Before these engines could be accepted as satisfactory something would have to be done to remedy the defect. As far as he could judge, the alternators, transformers, and mains were in every sense satisfactory. It was decided, on the motion of the Mayor, to print the two reports.

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Mr. Massey said he agreed with everything in Mr. Harpur's statement. The committee then proceeded to appoint a superintendent for the works. Three applicants had been asked to appear before the committee. Ultimately Mr. Neville Appelbee, of 4, Stafford-place, Buckingham-gate, London, was appointed. The salary attaching to the post is £200 per year.

PROVISIONAL PATENTS, 1895.

MARCH 11.

5086. **Improved means for connecting the branch wires of an electric lamp to the main conductors, or for other similar purposes.** Henry Schuster Cowx, 4, St. Ann's-square, Manchester.

5099. **An improved electric gas-lighter.** Friedrich Martin Kass, 70, Wellington-street, Glasgow. (Complete specification.)

5102. **Improvements in electric arc lamps for optical lanterns, projectors, and the like.** Arthur Barrett, 2, St. Mary's-passage, Cambridge.

5131 **Improvements in and relating to telephone apparatus.** William Bell Robeson, 45, Southampton-buildings, Chancery-lane, London.

5137. **Improvements in the construction and working of electrical transformers.** Sebastian Ziani de Ferranti, 27, Charterhouse-square, London.

MARCH 12.

5189. **Improvement in telephonic communication.** Thomas Tomlinson, 6, Fontenoy-terrace, Bray.

5196. **Improvements in thermo-electric generators.** Harry Barringer Cox, 46, Lincoln's-inn fields, London. (Complete specification.)

5199. **Improvements in telephone transmitters and in telephone receivers.** Charles Jackson, 7, Staple-inn, London.

5205. **Process for the production of electrode plates for electric collectors.** Carl Luckow, 5, Metzerstrasse, Cologne. (Complete specification.)

5231. **Improvements in or relating to the automatic regulation of the current carrying capacity of fuses for electric currents.** Francis Gibson Baily, 323, High Holborn, London.

5236. **Improvements in apparatus for starting electric motors.** Henry Willock Ravenshaw and Easton, Anderson, and Goolden, Limited, 1, Queen Victoria-street, London.

5269. **Improvements in mechanism for forming battery plates.** Charles John Reed, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, &c., Act, 1883, Sec. 103, September 12, 1894, being date of application in United States.) (Complete specification.)

MARCH 13.

5309. **Electric alarm for clocks.** William Taylor, 3, John-street, Bush Hill Park, Enfield.

5311. **Improvements in incandescence lamps.** Alfred Réné Upward, 150, Holland-road, Kensington, London.

5313. **Improvements in ohmmeters and other electrical measuring instruments.** Charles William Scott Crawley and Alfred Soames, 16, Red Lion-street, Clerkenwell, London. (Complete specification.)

5326. **An electrical safety stop for hydraulic motors.** William Carter and the Hydraulic Engineering Company, Limited, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5331. **Improvements in recording wattmeters.** James Devonshire, 24, Southampton-buildings, Chancery-lane, London. (Walter C. Fish, United States.) (Complete specification.)

5336. **Improvements in armatures of dynamo-electric machines.** Alexander Bewicke Blackburn and Thomas Large Boyden, 47, Lincoln's-inn-fields, London.

MARCH 14.

5385. **Improvements in telephony and telephonic apparatus.** Maxymilian Kotyra, 24, Queen Victoria-street, London.

5392. **Improvements in treating metallic tape used in the manufacture of submarine electric telegraph cables and for other purposes.** The Birmingham Small-Arms and Metal Company, Limited, and William Henry Greenwood, 7, Staple-inn, London.

5410. **Improvements in or relating to the means of protecting electrical conductors, water-pipes, and the like.** John Augustine Kingdon, 29, Marlborough-hill, London.

5428. **Electric transmitting thermometer.** Francis Napier Denison, 4, South-street, Finsbury, London. (Complete specification.)

MARCH 15.

5451. **Improvements in self-recording electric meters.** Arthur Wright, 26, Park-crescent, Brighton.

5515. **Improvements in electric measuring instruments.** Rookes Evelyn Bell Crompton, 55, Chancery-lane, London.

5521. **Improvements in electric couplings.** Octavius March, 40, Chancery-lane, London.

MARCH 16.

5568. **Improvements in alternating-current arc lamps.** William Phillips Thompson, 6, Lord-street, Liverpool. (Wilhelm Mathiesen, Germany.) (Complete specification.)

5596. **Improved construction and arrangement of commutators for dynamos.** Samuel Jevons, 166, Fleet-street, London.

5601. **Improvements in signalling and electric searchlight apparatus.** Sherard Osborn Cowper-Coles and Leonard William North Hickley, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1891.

3191. **Distributing electricity.** Von Dolivo-Dobrowolsky and others. (Second edition.)

1892.

19874. **Regulating electrical energy to lamps, etc.** Davis and Collins. (Second edition.)

1893.

10,942. **Voltaic batteries.** Walker and Wilkins. (Second edition.)

22053. **Secondary batteries.** Doubleday. (Sussmann.)

1894.

3469. **Dynamo-electric, etc., machines.** Pöschmann and Hanisch.

6057. **Electrical conductors.** Edmunds.

6721. **Signalling between police stations and call-boxes.** National Telephone Company, Limited, and Eggar.

7801. **Electrolytical apparatus.** Kellner.

7955. **Electric measuring instruments.** Thomson.

7994. **Electrolytic cell.** De Pass. (Thofehrn.)

8813. **Electric conductors.** Siemens Bros., and Co., Limited, and Dreselhorst.

23970. **Electric conductors.** A. and J. M. Anderson.

24625. **Electric safety appliance for railroads.** Orcutt.

1895.

1164. **Telegraph apparatus.** Damaskinos.

1544. **Electrical conductors.** Lewis.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5⅜
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅛-2⅜
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5-5⅛
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	15-15½
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	130-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2⅜-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	102 107
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1⅛-1⅛
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅛-1⅛
Elmore's French Company	2	—
Elmore's Wire Company	2	1⅛-1⅛
Fowler-Waring Cables	5	⅛-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	10-11
—— Preference	—	12
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7 9/16-7 11/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8⅛-8⅜
—— Pref.	10	13¼-14
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	⅛-¼
Metropolitan Electric Supply	10	10¼-10⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5⅛-5⅛
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	14⅛-15⅛
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7⅛-7⅜
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7⅛
—— £4½ shares	4½	6⅛-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅛-8
—— 7 per cent. Pref.	5	8⅛-9
Swan United	—	—
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7⅛-8
Yorkshire House-to-House	5	5⅛-5⅜

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NOTES.

Rangoon.—It is proposed to light the bank of the river at Rangoon by electricity.

State Telephony.—The telephone network of the Vienna Private Telegraph Company has now passed into the possession of the Government.

French Physical Society.—The annual meeting of the Société Française de Physique will take place on April 16 and 17 at 44, Rue de Rennes, Paris.

Lighting Quarantine Stations.—Powerful electric lamps are to be provided at the quarantine station at New York for the inspection of immigrants at night.

Gas Explosions.—As a set-off to the explosions in electric light manholes, *L'Energie Electrique* recently published a list of explosions of gas in different buildings.

Cable Repairs.—The "Pouyer-Quertier" has left Saint-Nazaire in order to repair the two secondary cables connecting the island of Saint-Pierre and North America.

Electro-Harmonic Society.—A smoking concert, the programme of which appeared in our issue of the 15th inst., will take place this (Friday) evening at the St. James's Hall Restaurant.

Pooling in the United States.—Arrangements are being made, a correspondent telegraphs, for "pooling" to prevent ruinous prices by the Westinghouse, Edison, and other great electric companies.

Wiring by a Supply Company.—An experiment is about to be made by the Berliner Electricitätswerke in the direction of wiring houses for consumers, in addition to the supply of electrical energy.

Laying of New Mains.—The London County Council have sanctioned the laying of new mains by the House-to-House Company, the Hampstead Vestry, the Westminster Company, the St. Pancras Vestry, and the Notting Hill Company.

Institution of Civil Engineers.—The annual banquet of this institution was held on Wednesday. Sir R. Rawlinson presided, and among the speakers were the Duke of Cambridge, the American Ambassador, and Lord Salisbury.

The Hodgkin Prize.—Lord Rayleigh and Prof. Ramsay have submitted to the Smithsonian Institute a joint essay regarding argon in the competition for the Hodgkin prize of 10,000 dollars for discoveries regarding the atmosphere.

Students of the Institution.—A paper by Mr. C. V. Drysdale, on "The Practical Measurement of Self-Induction," will be read at a students' meeting of the Institution of Electrical Engineers to be held next Friday, the 5th prox., at 28, Victoria-street, S.W.

Municipal Electrical Course.—The Paris Town Council have referred to the Fourth Commission a proposal made by M. P. Viguier, that a course in electricity should be established at the Hotel de Ville for the benefit of those employed in connection with the Hotel de Ville.

City Electric Athletic Club. — The winter entertainments of the City Electric Athletic Club (in connection with the City of London Electric Lighting Company, Limited) were brought to a conclusion on Tuesday by a Bohemian concert at the St. James's Hall, Regent-street.

Reduction in Chelsea.—The Chelsea Electricity Supply Company announce that, commencing with July 1st next, they will supply current at 6d. per Board of Trade unit with a sliding scale to 5d. for lighting purposes, and at 4d. per Board of Trade unit (by separate meter) for motors, cooking, and heating.

Exhibition at Brussels.—An international exhibition, under the patronage of the Government, is to be held in Brussels in 1897. It will comprise the applications of the arts, science, and industry; and electricity will form a prominent feature. The exhibition, which will be opened in May, will terminate in six months.

Liverpool Engineering Society.—The twelfth ordinary meeting of the present session will be held at the Royal Institution, Colquitt-street, on Wednesday next, Ayril 3, at 8 o'clock, when a paper on "A Scheme for the Distribution of Energy in Towns" will be read by Mr. Francis G. Baily, M.A., A.M.I.E.E., and Dr. C. A. Kohn, Ph.D., B.Sc.

The Recent Accident at Bristol.—In his report on the recent fatality at one of the transformer stations of the Bristol Corporation, Major Cardew recommends the enclosure of the high-pressure teminals and fuses in the transformer casing, and that the position of the high-pressure fuses on the switchboard at the generating station should be altered.

Electric Traction in Italy.—It is stated that Messrs. Tedeschi and Co. have placed a site at the disposal of the promoters of the Diatto system of electric traction with underground conductors for the purpose of demonstrating the method. It is also reported that Mr. Diatto has obtained for 10 years a concession for the working of his system on one of the Turin tram lines.

China and Burma Telegraph.—The Secretary of State for India has received a telegram from the Viceroy, stating that the junction of the Chinese and Burmese telegraph lines was effected on March 16, a month and a half earlier than the latest date fixed. This result was due to successful efforts made by the Telegraph Department to effect the connection as quickly as possible, and to the promptitude with which Chinese officers responded to those efforts.

Electrical Installations in Switzerland. — A paper dealing with an investigation of various electrical installations in Switzerland and Savoy has been contributed by M. A. Lavezzari to the *Proceedings* of the French Society of Civil Engineers. The paper, which is of a historical nature, describes the systems carried out for utilising the motive power of the Rhone at Geneva, the Salève electric railway, the Orbe tramway, the station of the Vevey-Montreux Company, and the Vevey-Chillon tramway.

The Government and Telephony.—In the House of Commons, on Monday, Mr. A. Morton asked the Chancellor of the Exchequer whether the nature of the proposals contained in the agreements with the telephone companies and the effect of those proposals would be placed before the Select Committee on Telephone Service. In reply, the Chancellor of the Exchequer said that he understood the agreements in question were already before the committee, and had been discussed by the witnesses.

Search-Lights for the Channel.—The Guildhall Battery site and buildings, for many years occupied by the headquarter staff of the South-Eastern District at Dover, are shortly to be vacated, and the staff offices removed to more convenient quarters. It is proposed to utilise the site for an electric light station to enable the Channel to be under the observation of search-lights from this point. There is no other point on the coast so favourable as Dover for observing the Channel, owing to the altitude of the cliffs.

Electric Cranes.—Some experiments were recently conducted at Havre with a new electric crane installed at the end of the Vauban basin on the Colbert Quay. The

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current, which is supplied by the Société l'Energie Electrique, is taken from the generators which furnish current for the working of the tramways. The motor, which actuates the mechanism of the crane direct without the interposition of gearing, runs at from 200 to 300 revolutions a minute. It was made by MM. Hillairet and Huguet, of Paris.

Protection of Overhead Wires.—Mr. Karl Moritz describes, with the aid of illustrations, in the *Elektrotechnische Zeitschrift* of March 21, an arrangement for the prevention of accidents in case of the breakage of a bare conductor carrying high-pressure current, or in the event of the wire becoming very slack so as to cause a short-circuit. The device consists in the use of insulators and auxiliary crossed wires. The system has been tested with success in the central station of the Hungarian Electricity Company at Budapest.

Personal.—Mr. Walter Dixon, of 164, St. Vincent-street, Glasgow, has been elected a member of the Institution of Engineers and Shipbuilders in Scotland.—Mr. T. A. Nunwick, formerly branch manager and representative in the North for Messrs. Poole and White, Limited, has now joined the firm of Messrs. Dorman and Smith, Salford, as their representative for the Northern and Midland counties.—Mr. Fred. Bathurst, A.I.E.E., has joined the General Electric Company for the development of the internal conduit system of wiring.

Coupling for Electrically-Lighted Trains.—Mr. J. B. Brunn, engineering inspector of the Danish State railways in Copenhagen, and Mr. Busse, have devised a new form of coupling for connecting together the conductors between each carriage in electrically-lighted trains. The coupling is intended to overcome the difficulty experienced with other couplings when the trains are passing round curves. A description of the coupling, with illustrations apparently taken from a patent specification, is given in the *Elektrotechnische Zeitschrift* of March 14.

Post Office Telegraphs.—In examining the parliamentary return of revenue and expenditure relating to the Post Office telegraphs, one cannot but notice the increasing proportion which the percentage of total expenditure bears to the amount of revenue. In the year 1870-71 this is given as 59·57 per cent., in 1875-76 as 85·96 per cent., in 1880-81 as 80·08 per cent., in 1885-86 as 102·52 per cent., in 1890-91 as 97·22 per cent., and for the year 1894-95 it is estimated at the figure of 109 per cent. The total estimated revenue for this last year is £2,665,000, as against an estimated expenditure of £2,905,025—showing a loss to this Department of £240,000.

Rating of Machinery.—Mr. Shaw-Lefevre received on Tuesday evening at the House of Commons a deputation representing the Property Owners' Association of Great Britain, who objected to the Bill exempting machinery from rating, on the ground that in some towns it would increase the general rating 4d. in the pound. Mr. Shaw-Lefevre, in reply, said they had come late, as the Bill had passed through committee. In giving the measure a general support, he had only followed the example of Mr. Fowler and Mr. Ritchie. He advised the deputation, instead of trying to destroy the Bill, to get an amendment passed exempting certain towns from its operations.

Water Power in Scotland.—In the House of Commons a few days ago, Mr. A. C. Morton asked the Secretary for Scotland whether the County Council and the Roads Board had yet come to any decision as to the interference with the Falls of Foyers. In reply, Sir G. Trevelyan said that he was informed by the county clerk of Inverness-shire that the Foyers Roads Board at a meeting on the 8th of this month had postponed the consideration of the proposal to submerge certain roads till the May meeting, meantime calling on the Aluminium Company to submit to the Board the plans and sections of the proposed works, in order to enable them to judge whether the district would be injuriously affected thereby.

Transmission of Power in Switzerland.—An article was published in *L'Industrie Electrique* of February 25, dealing with a scheme for the electrical transmission of 3,200 h.p. a distance of 15 miles. The project concerns the utilisation of the water power of the Reuse, several concessions for which were granted some years ago. The power was to be distributed between Le Locle and Chaux-de-Fonds. A competition was opened and several schemes were received, but these were rejected and new proposals invited. The jury appointed to consider the projects have now decided in favour of the adoption of the direct-current system. The scheme adopted consists in the transmission of electrical energy at a pressure up to 14,400 volts, the generators being connected in series.

Decentralisation of Work.—In contradistinction to the general tendency to centralise industrial operations, the Compagnie Minière, of Blanzy, are making an experiment in decentralisation. The company have a workshop at Montceau where the miners' daughters are taught, free of expense, how to weave and embroider. One of the principals of the company, M. de Gournay, has hit upon the idea of finding employment at home for these girls when grown up and married so that they may not neglect their homes. For this purpose he has arranged for the electrical transmission of power from the Saint-Amédée mine to Montceau, a distance of 4·3 miles. The cables are brought through the mining village of Magny, and leads will be taken into the houses for the operation of the looms. It is stated that this is the first experiment of this kind made in France.

Lighting in Calcutta.—The question as to when Calcutta is to have a regular supply of electricity for lighting and other purposes has been often asked and as often answered by the echo, "When?" But there does appear, *Indian Engineering* states, to be some prospect of the legislation deemed necessary in the matter being brought to an issue before the present year is out. It will be recollected that an Electric Lighting Bill was drafted last year to meet the requirements of the province of Bengal, and that this has been before the Imperial Government. It is some satisfaction to learn that the draft Bill has passed under the anvil, and, having assumed a final shape, will now come back to be considered and adopted by the local legislature. The want of the electric light, our contemporary concludes, is felt in many public, as well as private, buildings.

Electric Tramway Between Niagara Falls and Buffalo.—Everybody in Niagara Falls is rejoicing, says a Buffalo paper, over the letting of the contract for the building of the electric road between the Falls and Buffalo. The contract was signed recently in Buffalo. According to plans, the line is to be built of 94lb. steel girder rails, with side trolley poles. It is to be double-tracked except for a distance of 2½ miles, where the highway commissioners of the town of Wheatfield refused to grant more than a single-track line franchise. The best feature of all is that it will give Buffalo and Niagara Falls cheap fares, the rate to be but 2s. for the round trip at all times. The running of late cars will keep hundreds of Buffalo people in Niagara Falls until late in the evening, who now are obliged to go home before the really enjoyable part of the day about the

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Falls comes. The power for operating the line will be furnished by the Niagara Falls Power Company, and according to the contract the cars will be running by July 4.

London Telephone Service.—In a report presented by the Highways Committee of the London County Council on Tuesday reference was made to a previous report stating that, after careful examination of the proposed agreement between the Post Office authorities and the National Telephone Company, the committee were of opinion that the interests of the people of London would be prejudiced by the power to be given under the agreement to the company, whose existing monopoly would be further strengthened. A Select Committee on Telephony having been appointed, the Highways Committee have asked the deputy-chairman and the engineer to give evidence before it. The committee, moreover, think it advisable that one or more of the experts who advised them previously to the interview between the Postmaster-General and a deputation from the Council on February 4 last, should also give evidence before the Select Committee on behalf of the Council. The Council authorised the expenditure of a sum not exceeding £100 in connection with the matter.

Telegraphy and Telephony to France.—A Paris correspondent states that the telegraphic and telephonic cables between London and Paris have within the last month been so blocked with messages as to considerably interfere with the business which is carried on daily between the two capitals. At both the Bourse and the Bourse de Commerce in Paris there is a good deal of dissatisfaction with the existing arrangements, and representations are to be made to the French Minister of Posts and Telegraphs with a view to increasing the means of communication. The correspondent says that a telegram from London to Paris sent during the day often takes from one to three hours to reach its destination, while those anxious to use the telephone are obliged to take a turn which may reach them in two or three hours after the communication has been asked for. Under these circumstances, business in several branches of trade has become almost impossible between Paris and London. Stockbrokers and commercial men in Paris have very little faith, however, that any immediate result will be obtained by representations to the French authorities, and they hope that the attention which is thus drawn to the matter will induce those interested in London to urge upon the British authorities to take action.

The Chemical Society.—The anniversary meeting of the Chemical Society was held on Wednesday, Prof. H. E. Armstrong, the retiring president, being in the chair. The president, after mentioning that in giving up his office he severed 20 years' official connection with the society, referred to the Faraday lectureship and to the difficulty of finding men to hold it in view of the roll of distinguished persons on whom the honour had been bestowed. The discovery of argon was one of the most striking ever made in chemistry, and in recognition of the extreme value of his researches, as well as of his unwearied perseverance and consummate skill, the council had decided to ask Lord Rayleigh to be Faraday lecturer and to accept the Faraday medal. They did not ask him to deliver a lecture, but hoped he would give an address to the society on the subject of argon. In returning his thanks for the medal, Lord Rayleigh said that Prof. Ramsay stood on a footing of absolute equality with himself in regard to argon. The substance was isolated by Prof. Ramsay and himself independently, and he did not know who obtained it first. Prof. Ramsay then rose to make statement about argon. He had examined the gas (which according to an observation of Hildebrand's was nitrogen) given off by the mineral clevite when treated with sulphuric acid, and discovered that it contained argon. Spectroscopic examination showed a very bright yellow line nearly coincident with the yellow sodium line. This line was found to be identical in position with the yellow line observed in the spectrum of the sun's chromosphere, and attributed to the hypothetical element helium. Whether helium could be separated from argon remained to be seen.

Electrical Physics and Electro-Chemistry.—A lecture on this subject by Mr. Samuel Rideal, D.Sc. (London), was recently delivered at the Croydon County Polytechnic. The lecturer first considered the generation of electricity by chemical means. The uses and possibilities of secondary batteries were referred to, and then the chemical decomposition which takes place inside a cell was rendered evident by a number of experiments. The large production of chlorate of potash, of phosphorus, of aluminium, caustic soda and chlorine, etc., is now due in a great measure to electrical means, and examples of three processes were given. The aluminium furnace of Cowles and the electrolytic vessels used in other operations were shown by large scale diagrams and lantern projections on the screen. In addition to the practical uses of electricity in this direction, there are several scientific investigations in which it figures. Thus the Cavendish experiment to which is due the discovery of argon by Lord Rayleigh and Prof. Ramsay was repeated, and the production of ozone by means of the silent discharge was typical of the Andreoli and Fahrig systems already in commercial application. All such applications of electro-chemistry are either carried out in the neighbourhood of waterfalls, where a large amount of cheap power is available, or they may make use of the public supply of electricity to be found in all large centres of population. When electrolytic action takes place under circumstances where it is undesirable or unlooked for, then numerous troubles arise, such, for example, as the electrolytic corrosion of gas and water pipes, so prevalent in America, due to the very large leakage currents from electric railways, and in this country the explosions in conduits and culverts which have been so numerous lately. Experiments were arranged to illustrate these troubles and their probable causes, the lecturer submitting that they are probably due to true electrolytic action for the most part, and not merely to the alleged accumulations of coal gas in the underground passages and works. The appliances and plant used in the experiments form a part of the equipment provided for teaching purposes in the department of electrical engineering at the polytechnic.

Metric System of Weights and Measures.—The Public Control Committee of the County Council reported to the latter on Tuesday that the Weights and Measures Acts prohibit the use in trade of other than Imperial weights and measures. The system is little known or understood on the Continent, where the metric system of weights and measures is almost exclusively used. Export trade with foreign countries is therefore seriously hampered through having to be mainly carried on by the translation of Imperial weights and measures into their metric equivalents in accordance with a table appended to the Weights and Measures Act, 1878. In order to remedy a condition of things so injurious to the export trade of the country, and of London in particular, the London Chamber of Commerce has resolved to take early opportunity of bringing before Parliament, through its members and supporters in the House of Commons, a Bill to confer upon traders the liberty to use metric weights and measures for export trade purposes. The Council has been

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asked to assist the Chamber to secure the passing of the Bill. The committee entirely agree with the amendment of the law now proposed, and they recommended the Council to do all in its power to secure the passing of the Bill for the amendment of the Weights and Measures Acts, so as to enable metric weights and measures to be used for export trade purposes. The Select Committee of the House of Commons on Weights and Measures met on Tuesday, when Mr. H. E. Woolmer, of Manchester, gave evidence. He gave it as his opinion that the difficulties in the way of a conversion to the metric system in this country would not be great. For instance, in Germany 3½ years' notice was given of the change which was about to be made, and it was found that at the end of two years even the working people were quite conversant with it. He spoke of the difficulties which Manchester merchants under the present system experienced in carrying on foreign trade. The necessity for a change of standard was more intense now than 30 years ago, because so many more countries had adopted the metric system, and also because of the increasing keenness of competition. Mr. A. J. Street, chief inspector of weights and measures for the City of London, gave evidence as to the present use of the metric system within the City and the difficulties which would probably attend its general adoption. In his opinion there were a great many wholesale houses and a number of bullion merchants who would welcome the metric system, but on the whole the retail traders were very much against it.

Electric Power for Canal Boats.—Experiments with the use of electric power in connection with canal boats are being made both in France and in the United States. According to the New York *Electrical Engineer*, the Lamb system is affording satisfaction. The results, our contemporary says, have demonstrated the system to be entirely feasible for canal-boat towing, and the Trenton Ironworks, of Trenton, N.J., who are introducing the system, stand ready to guarantee its successful working. The distinctive feature of Mr. Lamb's motor is that, unlike all others heretofore tried in telpherage systems, it is propelled by friction obtained independently of the weight of the apparatus. The motor can, in consequence, travel up the incline due to the sag in the cable net on approaching the brackets. The recent test was made to demonstrate the ability of the machine to tow a boat around sharp reverse curves. The deflection of the cable at each bracket was 6deg., and the motor pulled the boat at full speed around the right and left curves with ease. By this test it is proved that the motor can pull a boat around the sharpest curves to be met on any canal, as the tangents can be made as short as desired by placing the brackets close together, and a deflection of 6deg. be made at each bracket. On canals where the traffic is light a single cable can be used, and when boats going in opposite directions meet, they can exchange motors and proceed. This is done by exchanging hawsers. The low cost of the cableway makes but a light fixed charge for interest when two cableways are used. One of these cables would be erected on the inside of the tow-path, and the other on the berm of the cable on the opposite side. The mule traffic can, in consequence, be continued while the electric motors are in use. The system requires no changes in the present methods, as the electric motor simply takes the place of the mules. In this particular, this system has an advantage over all others, as the additional earning capacity of a boat due to the extra room thus gained is a very considerable item during the course of a year. Mr. Lamb claims that in comparison with electric propeller systems designed on the principle of the trolley all the disadvantages encountered in the recent State experiment on the Erie Canal are overcome by his system. These difficulties are, that the boat has to be steered so as to keep the trolley on the wire; the difficulty of two boats going the same way and the rear one passing the front one; on disconnecting the trolley, the boat loses its power and cannot proceed to get ahead of the boat in front of it. In the Lamb system they steer by each other and exchange motors and proceed.

The Protection of Electric Circuits.—Mr. W. E. Harrington read before the Cleveland meeting of the National Electric Light Association a paper on the "Correct Method of Protecting Electric Circuits.' He stated that the use of fuses for the protection of electric circuits has proved unreliable and unsatisfactory. The adoption of magnetic circuit breakers being, as it is, a foregone conclusion, led the author to make a study into the requirements entering into what would constitute a technically correct form of magnetic circuit breaker. The utilisation of the principle embodied in Helmholtz's formula gives the solution to the problem to determine the correct method of protecting electric circuits. The use of fuses for the protection of circuits has proved to be so antipodal to the fundamental principle contained in what is the severely technically correct method, that it is criminal, almost, in the light of present practice, for users to follow like sheep in the path of their predecessors in the use of fuses. The practical interpretation of the formula in question indicates clearly that if a circuit be opened during the rise or first surge in current upon a tendency for abnormal flow, and, further, if the time of opening be made as quickly as possible, the less the resulting flow of current will be. The hitherto standard form of magnetic circuit breaker, and the type familiar to all, is immeasurably preferable to fuses, in so far as it opens the circuit much quicker on the score of time. Fuses open the circuit so late after the heavy unusual condition of circuit is established that the current reaches the high and parallel part of current curves. A magnetic circuit breaker should be constructed to open the circuit in less and less time as the conditions become more and more severe. This can be done by taking advantage of the flux of lines of force due to the passage of the current, since, fortunately, the two are simultaneous; and by designing the magnetic circuit breaker to open as regards time in an inverse ratio to the increase of the lines of force, and not depending on springs or gravity, except, possibly, as auxiliaries to act as potential energy to aid in overcoming the inertia of the switch jaws and arms. We have then the correct method of protecting electric circuits. The destruction of electrical apparatus, the breaking down of insulation, the burning out of circuits, is taken by the business managers of electrical stations with a meekness and non-effort for relief which is astonishing. What business manager would permit his boilers to run with safety-valves of such a type that an increase of 500 to 1,000 per cent. of pressure would be required to open them? The author has repeatedly made tests showing that a No. 21 B. & S. gauge copper wire would permit the passage of 450 amperes for $\frac{3}{100}$ of a second without burning out or changing colour. In conclusion, the author stated that all switchboards and minor lighting circuits should be protected by automatic (as regards time element) magnetic circuit breakers, and the urgency of this will appeal to the exchequer of the management of the many electric light and power stations when the full meaning and import of Helmholtz's law dawns upon them.

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THE THEORY OF ALTERNATING CURRENTS.

BY A.INST.E.E.

§ 1. **Introduction.**—Probably no branch of electrical engineering presents so many difficulties to students as that which deals with alternating currents, and as new terms and units, as well as relationships, not encountered in the study of continuous-current problems, are now every-day expressions, no apology is necessary for presenting this series of articles on the theory of alternating currents as an introduction to a more thorough study of this important branch of electrical science. As these articles are more particularly intended for that large class of young electrical engineers who have not had the opportunity of attending the courses of instruction at our technical colleges, we propose to introduce the various principles underlying the subject by briefly explaining the physical facts, so that the definitions of the units and terms in common use may be the better understood; and, although it is not to be expected that we can dispense with mathematics and mathematical language, yet it is hoped that the pains taken to simplify the mathematical relationships of the subject will enable the earnest student to master the fundamental principles of this important subject. As is well known, the study of alternating currents is a complicated one, simply because inductance and other factors affect such currents to a degree impossible with continuous currents, so much so that Ohm's law in its usual garb is not applicable to alternate-current circuits. These factors are so important that we shall tackle them singly, and shall first deal with the phenomena of self-induction and the practical unit of inductance—the henry.

§ 2. **Induced Currents and Self-Induction.**—Although it had been known for ages that a very close connection existed between the phenomena of electricity and those of magnetism, it was not until 1820, when Oersted, of Copenhagen, made the remarkable discovery that a current of electricity exerts magnetic influence in the surrounding space, and deflects a magnetic needle placed in the neighbourhood of the conductor through which a current is passing, that a satisfactory explanation was possible. Without doubt the announcement of Oersted marked the beginning of a new era in the history of physical research, the results of which were so startling, and the physicists of the time so stimulated, that in a wonderfully short time the foundation of the whole superstructure of electrical engineering was firmly established. Within two months of Oersted's discovery, Ampère gave to the world the results of his investigations in electromagnetism, and enunciated the laws respecting the dynamical action between linear conductors carrying currents. But the most brilliant achievement was that of Faraday, who, having explained the influence of a current or a magnet upon the surrounding medium, discovered in 1831 that a current is induced in an independent circuit placed near a magnet whenever the relative positions of the two change. This was the converse of Oersted's discovery, and, strange to say, the same discovery was independently made in America about the same time by Prof. Henry, who also has the honour of anticipating Faraday's later discovery by observing the phenomena of an induced current by an electric current in its own wire. The explanation of this, however, was reserved for Faraday, who two years later, traced it to its cause.

By considering what takes place when a current is sent through one of two closed circuits, P and S, shown in Fig. 1, placed in each other's vicinity, we shall get a clear insight into the cause of induced currents.

A steady uni-directed current established in P creates a magnetic flux of constant intensity and permanent position relative to P, and n lines of this flux thread through S, the value of n depending on the position of S relatively to P. The lines embraced by S will not vary so long as the current in P is constant, and no current will be induced in S until the relative positions of S and the lines from P change. An induced E.M.F., however, is at once set up in S immediately relative motion takes place between the lines of force and the coils of S, in consequence of which the value of n changes, and a momentary induced current flows round S in the direction indicated, which is opposite to the inducing current. Relative motion may be produced in several ways, the following of which are self-evident:

(1) By moving S or P.

(2) By stopping the current in P, since if there be no current in P there will be no lines in S; this is equivalent to withdrawing S.

(3) By varying the strength of the current in P; and

(4) By making the current in P intermittent, or by sending an alternating current through P.

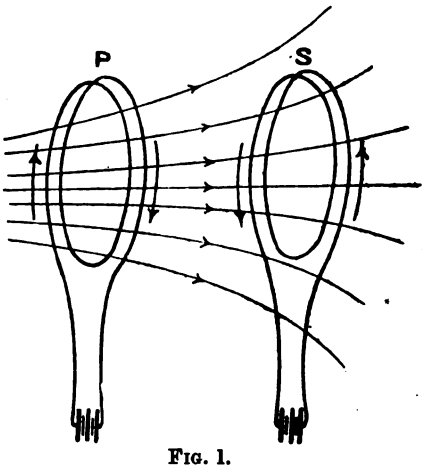

FIG. 1.

§ 3. If the current in P increases from zero to its full value, C, the flux passing through S increases from zero to n; and it must be noticed that if S contains m turns of wire, then each of the n lines cut, or is linked with the m wires—that is, we have $m\ n$ linkages—and if the current in P increases from zero to C units in one second, then $m\ n$ measures the E.M.F. induced in S during that second, and the pressure thus developed is termed the E.M.F. of *mutual induction*. Let $m\ n$, the product of the number of turns into the number of lines linked with them in one second whilst the current in P increases from zero to unity, be denoted by M, then the quantity M is treated as a constant, and is defined to be the *coefficient of mutual induction*, or the *mutual inductance* of P and S. It may be proved by experiment that unit current passing through S would produce M linkages in P under similar conditions; therefore the coefficient of mutual induction of two adjacent circuits is the quantity of magnetic induction passing through either of them produced by unit current starting in the other.

Since the flux in P is directly proportional to the current, it follows that when C units of current pass through P, that S encloses M C lines, and the E.M.F. induced in S during the setting up or collapsing of this current is M C units. As the number of lines threading S depends upon the relative positions of P and S, it is obvious that the maximum number is embraced by S when the two coils are co-axial, so that their centres coincide. It is also evident that since a current in a conductor acts inductively upon neighbouring circuits, it must also have a similar action upon itself whenever a change occurs in the strength of the current, and an induced E.M.F. is developed in its own wires, the direction of the induced E.M.F. being opposite to the E.M.F of supply. In other words, a back pressure is produced, the tendency of which is to obstruct the current in its own path. This back E.M.F. is greatest when the intensity of the flux within the coils changes from zero to a maximum, or from a maximum to zero—that is, when a circuit is made or broken. Thus, on closing a circuit of a voltaic cell, a definite fraction of time elapses before it establishes a current of constant strength, and during this time the E.M.F. of supply has to do work against the back pressure it is inducing. This was the discovery made by Henry, who termed such phenomena *self-induction*.

When such a current is broken the flux is gradually withdrawn from the coils, and this is equivalent to the flux linking the coils from the opposite side, and the E.M.F. is thus in the same direction as the E.M.F. of the cell. Naturally the current itself tends to continue in

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motion, and in this it is assisted by the induced E.M.F., with the result that the pressure is so great that an exceedingly bright spark is produced. This property, in virtue of which a current "tends to go on" when the circuit is broken, is sometimes termed "electric inertia," and this idea is very useful in assisting us to remember that it is impossible to produce any instantaneous change in a current when self-induction is present in a circuit.

§ 4. As we have already inferred, the magnitude of self-induction, or *inductance*, as it is also called, present in a circuit in which the current strength varies depends upon the magnetic qualities of the circuit, which depend upon the current passing, the form and size of the coils and the presence of iron. And since alternating currents pulsate alternately in positive and negative directions at a rapid rate, it follows that the effects of self-induction are of considerable magnitude, and are almost as important as those of ohmic resistance—so much so, that it is necessary to be able to determine it quantitatively; hence a unit of inductance is required. In the absolute system of units we have an absolute unit of back E.M.F. when we have a change in the number of linkages, at the rate of one linkage per second, due to a change in the strength of the current at the rate of one absolute unit per second. If the change is L linkages per second due to change of unit current, we shall get L C linkages, when the current changes at the rate of C units per second. L is a constant, and is termed the *coefficient of self-induction*, which is defined as follows: the coefficient of inductance of a circuit is the quantity of induction passing through it per unit current in it.

The above unit, however, is too small for practical purposes, consequently 1,000,000,000 or 10^9 absolute units has been adopted as the practical unit, and is termed the *henry*. Thus, in practice, when the current increases uniformly from zero to one ampere in one second, and a back pressure of one volt is produced, the inductance of the circuit is one henry. The connection between the absolute unit and the practical unit of induction may be determined as follows:

$$\text{Back E.M.F.} = \text{inductance in henrys} \times \text{amperes},$$

or

$$E_s = L \times C;$$

where E_s is the self-induced E.M.F., L the number of henrys, and C the current in amperes.

Now, one volt $= 10^8$ absolute units of pressure,
and one ampere $= \frac{1}{10}$ absolute unit of current.

Therefore, if E_s and C are each unity, then

$$\text{one volt} = L \times \text{one ampere};$$

therefore, in absolute units, $10^8 = L \times \frac{1}{10}$, that is, $L = 10^9$ absolute units, as mentioned above.

In words, if a coil consists of one turn of exciting wire, then 10^9 lines of induction must cut it in one second so that we may have an inductance of one henry.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 28.

At last night's meeting of the Institution the following paper was read:

On the Employment of the Electric Light for Railway Purposes.

BY W. LANGDON, MEMBER.

Having regard to the general character of the title of this paper, the author is desirous it should be understood that the data referred to are the result of experience gained on the Midland Railway. The Midland Railway was by no means the first railway company to employ the electric light for traffic purposes, and the author lays no claim to priority in this respect. On the contrary, he readily recognises the prior claims of others, and he earnestly trusts that his friends and *confrères* will feel no hesitation in bringing forward such information with respect to their own systems as may add to the value of the subject. It is well known that the Great Western Railway, the London and South-Western, the Brighton Company, the Lancashire and Yorkshire, the Caledonian, the Manchester, Sheffield, and Lincoln, as also the Glasgow and South-Western, have for some time, more or less, entered upon the employment of the electric light, and that the London and North-Western is now applying it to its goods depôts. The most material advance will, however, be found in the central stations recently established, in the one instance by the Great Northern Railway Company, under the guidance of Mr. W. H. Preece, C.B., F.R.S., past-president, at Holloway; and in the other instance that laid down for the Great Eastern Railway at Liverpool-street by our president, Mr. R. E. Crompton, C.E.

From all no doubt can exist that material information is to be obtained—information of value not only with regard to the question of economy, but also in the mode of application. In both the Holloway and Liverpool-street plants we have comprehensive schemes, the product of men of large experience and of the highest ability, from which results of an exceedingly gratifying character may well be anticipated. The electric light is employed on railways, as in towns, under its two forms—viz, incandescent and arc lighting.

Incandescent Lighting.

Incandescent lighting has so far found its chief employment in the illumination of offices, waiting-rooms, and other spaces of limited area. So employed, its claims upon our consideration are those which it has established in relation to our homes—a purer and more healthful light than can be procured from any other illuminant. In offices where a staff of workers are in constant attendance, or where, from the exigencies of the moment, work has to be carried on to a late hour of the night, it becomes to railway companies, as to all other employers of office labour, a factor of importance. To impute to the vitiated air breathed by those who occupy close rooms lighted by gas all the ills to which flesh is heir, would be absurd; still, so long as the air we breathe is robbed of its oxygen and otherwise polluted by the impurities cast into it by whatever may be the source of illumination employed, there can, in point of healthfulness, be no comparison between it and the electric light.

The argument against the electric light for the illumination of offices, waiting rooms, etc., is usually one of expense. With a small installation, or where the current has to be obtained from a supply company, the cost is at present, in most instances, probably greater than that of gas; but it is open to doubt whether such is really the case when we take into consideration the cleaning and redecorating of such places. We all know the effect of gas and the inconvenience of being turned upside down periodically for cleaning purposes. If we save by the electric light but one cleaning in three, it is probable that even the drawbacks of a small installation, or the present cost of current when obtained from an outside source, are fully met. If to these arguments we add that of health, we have a factor which carries with it far greater weight, and merits far more consideration at our hands. Health is money in more ways than one. It is money to the employer. It is more than money to the employed. It means to the employer more constant attendance, greater energy, and greater devotion to work on the part of the employé—gains alike to master and man. Whether the incandescent light may not yet prove of considerable service for the upper floors of goods warehouses, where light is only occasionally required, is an open question; and although in such places its advantages in a hygienic sense may be disregarded, it is, with a sufficiently large installation, quite within the realms of economy.

Wherever electric lighting is produced by a local generating plant every increase in the output of current tends to reduce cost. All such additions mean very little additional expenditure in production of current. The first cost is no doubt more than that for gas, but when we reach that point where the annual cost of the light produced is less than that of gas, such extra first cost is soon recovered. The directors of the Midland Railway Company have only recently installed the incandescent electric light throughout the offices, waiting-rooms, etc., of the Derby Station and headquarters offices. There is but one opinion of the result. The staff already feel the benefit of it in point of healthfulness and comfort, and the rooms and offices are practically as clean at the present moment as when the light was started. In the "shipping" offices—offices usually located on the platforms of goods-sheds, for the purpose of dealing with invoices, etc., and, as a consequence, necessitating very late, and sometimes all night, attendance—the advantage of the electric light is still more intensely felt, for in these offices an abundance of light is a necessity.

Arc Lighting.

There is reason to believe that arc lighting is destined to be of great advantage in railway working. In the loading and unloading of stock, and in the marshalling of trains, it is an invaluable adjunct. To be able to unload a train, load its contents into trolleys ready for delivery, and, *vice versâ*, to transfer from the collecting van to the railway trucks, marshal and despatch them with speed, is economy in capital, men, material, and time—results which are not confined to the depôt at which it originates, but which to a great extent influence the traffic of the entire system. The advantage of the arc light in goods

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warehouses, yards, sidings, and marshalling grounds presides in the simple fact that it is a larger and truer light than can conveniently be obtained from gas for a similar outlay. By this larger light work is handled with greater accuracy and greater despatch. To be able to load a given number of trains in, say, three-fourths the time formerly occupied, is tantamount to increasing the capacity of the premises, warehouses, yard, etc., 25 per cent. ; or, supposing a depôt required enlarging in order to meet an increased traffic, the introduction of the electric light should meet the contingency, and avoid purchase of land, erection of additional buildings, etc. In like manner, with new buildings, economy in time means economy in capital outlay : the buildings need not be so large, because the traffic can be disposed of in less time.

Probably to no part of a railway system is the electric light of greater utility, or more valued, than in yard shunting, or the marshalling ground. With a brilliant light at the junction points the marshalling process may be carried on with almost the same despatch and certainty as during broad daylight. Risk of life and limb is largely reduced, whilst it has been found to be in no small degree useful in preventing that petty pilfering to which the absence of light is often an inducement. The author believes it to be a fact that the first arc lighting plant installed for yard working—viz., that at Nine Elms, which was devised by Mr. W. H. Preece, C.B., F.R.S., past-president, and installed by Mr. R. E. Crompton, our present president—was laid down mainly with a view to suppress certain depredations on valuable goods which the absence of light appeared to foster, and upon which its introduction has had so marked an effect as to help largely to defray the cost of the installation. Although, as already stated, by no means the first to employ the electric light, the Midland Railway was not long in recognising its advantages. In 1889 its adoption was recommended by Mr. G. H. Turner, the company's general manager, who at that time filled the post of goods manager, and who recognised in it one of those aids towards the rapid handling of material which at that time so largely occupied his attention in relation to the remodelling of many of the company's goods stations.

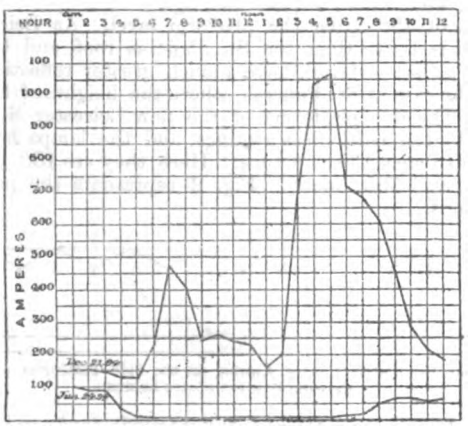

FIG 1.—Diagram of Maximum and Minimum Load at Derby.

In this remodelling of their chief goods depôts the directors have called to their aid all the most modern improvements, and amongst these that of the electric light. There is nothing of a purely novel character in the application of the electric light to these improvements, and the author feels that only in illustration of its general application and usefulness under aspects, perhaps, slightly varying from those which are associated with it in its use for public street-lighting, can this paper lay claim to consideration.

The first electric lighting plant laid down on the Midland was that established for lighting the St. Pancras Hotel. The generating plant established for this service is in duplicate, and consists of a simple non-compound horizontal steam-engine and two dynamos, each set being of 28-kilowatt capacity. The number of lights in the hotel is equal to 1,330 8-c.p. lamps at 110 volts, and the maximum load reached has been 320 amperes. The light load is met by accumulator cells, the dynamos being so arranged that one of the two driven by each engine can be employed for charging them, while the other is furnishing current direct to the lamp. The first arc lighting plant laid down was that experimentally installed by Messrs. Laing, Wharton, and Down, as representatives of the Thomson-Houston system, in 1888, at St. Pancras. The lighting was confined to the passenger station. In 1890 this plant was purchased by the Midland and extended to the St. Pancras goods station and yard. Insulated overhead wires—partly okonite, partly vulcanised—were employed. The installation has from time to time been largely extended, and now consists of 242 2,000-c.p. (nominal) arc lights, employed on the St. Pancras passenger station, the St. Pancras goods station and yard, the Somers Town (or New St. Pancras) goods warehouse and yard, sidings and approaches.

The engines employed for this installation consist of two pairs of simple horizontal non-compound steam-engines (coupled) served by locomotive boilers, three 50-light Thomson-Houston dynamos, being worked from countershafting driven by each pair of engines. This countershafting was originally arranged so that it might be coupled for cross-driving if needed, but up to the present no such need has presented itself. The engines were made and placed in position by Mr. Sam. Johnson, the company's locomotive engineer, and it is impossible to speak too highly of their performance. The electric lighting plant now in use or under construction on the Midland is approximately as represented in Table I. :

TABLE I.

Engine b.h.p. Steam.	Engine b.h.p. Gas.	Locality.	Arc lights. 2,000 c.p.	Arc lights. 1,250 c.p.	Incandescent 8 c.p.
200	90	Bradford	—	190	1,100
190	—	Leeds (Hunslet goods depôt)	—	150	523
190	—	Sheffield (Wicker goods depôt)	114	—	300
190	—	Liverpool (Sandon Dock)	—	126	100
190	25	Birmingham (central goods)	73	—	435
300	—	,, (Lawley-street)	—	200	400
320	—	Derby	—	—	4,500
—	250	Leicester (passenger and goods)	160	—	400
300	—	St. Pancras ,, ,,	242	—	—
—	—	,, Hotel	—	—	1,330
200	—	Nottingham	55	75	300
—	40	Wellingborough	35	—	100
2,080	405		679	741	9,488
2,485			1,420		

Steam may be said to be employed throughout, with the exception of Leicester and Wellingborough. Leicester—which will be dealt with more in detail later on—and Wellingborough are dependent upon gas. A small gas-engine is also employed at Bradford and Birmingham (central) for the light load ; and, owing to want of space for extension of boilers at Bradford, we are now laying down two 40-h.p. gas-engines to meet an extension of arc lighting there. The boilers are in all cases of the locomotive type. The type of steam-engine varies. At Bradford some 200 h.p. of the engines are identical with those previously described as in use at St. Pancras. At Birmingham (central goods and Lawley-street goods), and at Sandon Dock, Liverpool, horizontal two-cylinder simple engines by Davey-Paxman are in use. At Leeds, two-cylinder simple by Fowler ; at Sheffield, single-cylinder steam jacketed by Marshall ; at Derby, Willans and Robinson single-acting compound ; all are non-condensing. The Willans and Robinson engines at Derby drive direct ; and, with the exception of St. Pancras and Bradford, where counter-shafting is employed, the driving is by belting direct from the engines. The engines employed for the arc lighting are generally 80 h.p., and are provided with two flywheels, each driving an arc dynamo.

At Leicester, with the object of testing the economy, or otherwise, of a gas-driven plant as against steam, a gas plant has been laid down. It has only recently been brought into use, and the installation is not even yet complete, the new passenger station being still in progress. A Dowson gas plant has been installed, and connection with the town gas has also been provided. The valves in the supply pipes are so constructed that either form of gas can be laid on to the engines without stoppage of the latter. The generating plant consists of four 50-h.p. gas-engines for driving three arc machines and one low-tension machine, and two of 25 h.p. for two small incandescent dynamos.

ARC LIGHTING SYSTEM.

Throughout the service the arc lighting employed in the yards and shunting grounds is on the series system. In certain of the goods sheds the series-parallel—two lights in series—system is used. Brush series machines are in use at Leicester, the Thomson-Houston at all other points.

INCANDESCENT SYSTEM.

The machines laid down for incandescent lighting are from various makers—Siemens, Edison, Hopkinson, Elwell-Parker, and Holmes. The incandescent lighting, with the exception of Derby, is on the simple parallel system. At Derby the three-wire system, with feeders, is in use. The blocks of buildings in this case are somewhat scattered, and the generating station itself is situated some distance away from the lighting. It is practically a small supply station, with, at present, a very bad load-factor (Fig. 1), much worse than that of a town supply station. Here, as also at Bradford, Sayers's automatic compensators are employed to counteract the fall of potential as the current increases.

The Midland Bradford Station, as is perhaps well known, is electrically lighted throughout, with the exception of a few gas lights under some low awnings at the distant ends of the platforms. Originally the incandescent lighting was provided for by compounded machines in duplicate. To change over from the working to the duplicate set involved careful handling on the part of the attendant. Discussing the matter with Mr. J. Sayers,

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my assistant, under whose supervision Bradford came, it was decided to insert a series machine in one main and to dispense with the compounding. In the end this resulted in the employment of Sayers's "compensator," and which, I believe, was the first self-exciting machine made without winding on magnets. The application of this machine has been attended with the most perfect success. The transference of the load from the active to the duplicate set is now simply that from one shunt machine to another, while the compensation of the loss in pressure consequent upon the increase in current is most perfectly met.

At Bradford the wiring is on the simple parallel system. At Derby Dr. Hopkinson's three-wire system is in use. The success attending the employment of Sayers's compensators at Bradford naturally suggested their employment at Derby. At Bradford the extent of the compensation is limited to 11 volts, with a maximum current of 320 amperes. At Derby we have to serve a network, and the compensation is more involved, owing to the loss in the middle wire when either of the two sets of three separate groups of feeders is unevenly balanced. Dealing with one set, the arrangement is as follows: The outside wires of the grouped feeders are connected through a series machine driven by motor at a constant speed of 820 revolutions. This compensates for the loss in each outside wire. The loss in the middle wire is, of course, double-acting, raising the volts on the light-load side and depressing them on the other. To meet this, Mr. Sayers takes the middle wire round the magnets of each of the two series dynamos, but in opposite directions one to the other. Any current passing in this wire therefore adds volts to one, and decreases the volts in the other, equally; and by suitably proportioning this winding it can be made to practically neutralise the loss in the third wire. If both sides are fully loaded, and there is no loss, or no current passing in the middle wire, each series machine has to raise the voltage, on a current of 350 amperes in each, some seven volts; but as the third wire is one-half the section of the outer wires, it follows that if one side should be fully loaded and the other not loaded at all, the compensators have to give 7+14=21 volts, and this they should do under the arrangement provided.

Such an extreme case never has arisen in practice; still, serious differences do occur—more so, perhaps, in such a supply as that under reference than in a town service—for the reason that, however equally you may plot out your scheme, it is quite impossible to foresee all those contingencies which, calling for extra attendance on the part of a special branch of the service, call for the load on that side accordingly. A further advantage to be derived from the use of these compensators is to be found in the regular range of speed at which the engines require to be worked between light and full load. The volts of the main dynamos only require to be kept at the normal pressure—say, 110. There is no need for running the speed up so as to increase voltage to meet the drop consequent upon increase of current. It is one of those arrangements which simplify the working of a station at moments of pressure.

Installation.

The establishment of the various installations, with the exception of that originally laid down by Messrs. Laing, Wharton, and Down at St. Pancras, has been carried out by the company's own staff, under the immediate supervision of the author and his assistants, Mr. W. L. Preece and Mr. J. Sayers, and no small portion of the fittings required have been made in the company's electrical workshops. Arc lighting wires not employed for the interior of buildings are laid underground. When drawn into iron piping, the wire is not armoured, but is protected by an extra outer serving of flax, hemp, etc. When armoured wire is used it is protected by ordinary drain tiles, split, or by planks of wood, employed more with the object of indicating to those who may have occasion to disturb the ground in its neighbourhood the fact that there is something beneath it than with any idea of its power to absolutely resist injury. The insulation of the cable thus employed is specified at 5,000 megohms. Arc lighting wires inside buildings are insulated with vulcanised indiarubber to not less than 300 megohms, and are, as a rule, supported on Johnson and Phillips's oil insulators. All suspended lamps are also insulated from the suspension fixing by oil insulators made for the purpose by the same firm.

For goods-yard and siding working the selection of the positions for the lamp pillars, and the height the lamp should stand from the ground, are matters of importance. The former is only to be dealt with in a satisfactory manner by learning from those who have the handling of the work, and by personal observation where the light is most needed. Each group of points requires special consideration. Shunters should be able to see when wagons have passed over each point, so that they may readily "knock off" the next wagon or group of wagons as the required points are clear of the trucks previously despatched over them. At the mouth of the Leeds goods yard, where there are four roads, a light girder bridge has been thrown across, from which three lights are suspended between the roads, and the lighting is in consequence very good. The point is an important one, as from each line several fans of roads radiate, and it is beneath this bridge that the main part of the shunting is done. Without the girder bridge it would have been impossible to adequately light the intervening spaces between the roads.

Two classes of lamps are in use—that affording what is termed 1,200 c.p., and that known as 2,000 c.p. The former requiring a current of 6·8 amperes, and the latter 10 amperes, the 10-ampere lamp will afford a larger body of light than will the 6·8-ampere lamp. In station buildings, where structural arrangements do not intervene, the 10-ampere lamp illumines a larger space than that produced by the lesser current, and is, as a rule, arranged at a higher elevation, and further apart in consequence. In goods-yards and open spaces, theoretically, they should illuminate an equal extent of area. In point of fact, however, the illumination does not bear the same relation as when within enclosed spaces. Again, it may be said the 10-ampere lamp should be arranged at a higher elevation than the smaller lamp, but on the Midland it has been found convenient to employ only one class of pillar for outside work. The height adopted is 20ft.—*i.e.*, 20ft. between the arc and the level of the rails. The distance these pillars are apart varies for the 6·8-ampere lights from 90 to 100 and for the 10-ampere lights from 100 to 120 feet. The distance between the lamps in the goods sheds must, in a great measure, be controlled by structural arrangements, cranes, etc. In open sheds, where these difficulties do not exist, a distance of 45ft. between 6·8-ampere lamps and a distance of 60ft. between 10-ampere lamps will be found convenient. Every case will, however, call for special consideration and treatment. To lay down a rule which shall be universal and at the same time useful, is practically impossible.

The lights employed on the St. Pancras passenger station are 10-ampere. At the head of the station those lamps are 60ft. apart, the space between them increasing towards the end of the platforms, where the passenger traffic is not so heavy, the distance between the two most distant lamps being 90ft. The height of these lamps from the platform is 14ft. On the Leicester passenger station main platforms, where 10-ampere lights also are used, we are able to place the lights 90ft. apart, and at an elevation of 15ft. from the platform level. At Leicester the glass roof is lower than the St. Pancras roof, and the walls, being of glazed material, have a much greater reflecting power than is the case at St. Pancras, where the height of the lamps is 14ft. The side platforms of the new Leicester Station are covered by the usual glass awnings, and the lamps have to be arranged to meet the structure. Here they are 13ft. above the platform and 75ft. apart. Fig. 2 represents the position of these lamps.

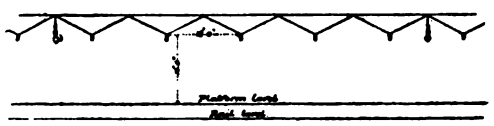

FIG. 2.—Longitudinal Section of Awning on the Side Platforms at Leicester showing Position of Arc Lamps.

In the Birmingham (Lawley-street) goods depôt and yard, the lights employed are of 6·8 amperes. Fig. 3 will probably afford a better idea of the disposition of the lights for such yards and buildings than will any written description. Within the warehouses, the cranes, with their radii, are lettered, while the pillars are coloured black. The Lawley-street depôt is still in an incomplete condition. A range of offices—now

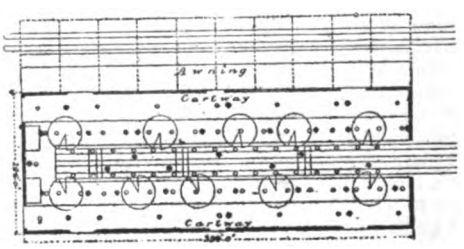

FIG. 3.—Plan showing Gas and Arc Lamps at the Central Goods Shed, Birmingham. Arc Lamps are indicated by an asterisk and Gas Lamps by a circle.

about to be constructed—will occupy the Lawley-street frontage, and the space between these offices and the main warehouse will be covered in by an awning. The lamps employed are double-carbon, jointly affording 16 hours' lighting; 13-mm. carbons are used for the 10-ampere lamps, and 12-mm. for the 6·8-ampere lamps, for both top and bottom carbons. In the earlier plants laid down the lamps are protected by sheet-iron hoods, A (Fig. 4). The lamp is suspended from a cross-piece of timber, B, by insulated hooks, or hangers, C, and it is further supported at its base by an insulator, D. Later constructions have been equipped with four-sided lanterns, Fig. 5. The top portion of the lamp is insulated from the lantern at A by a block of dry wood and insulated hooks, and

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the base, as in Fig. 3, is supported on an insulator, B. These lanterns have been glazed (*a*) with plain clear glass, (*b*) with what is termed "blurred" glass, and (*c*) with fluted glass. The clear glass can be used only to a limited extent. The naked arc is objectionable to men working within its immediate range. Clear glass is perhaps still more objectionable, from the strong shadows which attend its use. "Blurred" glass has been employed with the object of toning down the glare of the arc and breaking up the shadows. It is, however, not in this respect so successful as the fluted glass. With the flutings horizontally arranged the shadows are completely broken up, and the refraction is so good that the light immediately underneath the pillar is practically as good as that 10ft. distant. The lanterns are made so that the chimney may lift off at A. All lamp-pillars are provided at their base with switches which entirely sever the connection of the lamp wires with the line wires, and in all modern constructions the switch, when in the "off" position, also places the lamp to earth. The lamp-pillar complete is shown in Fig. 6. The switch is enclosed in the base of the pillar.

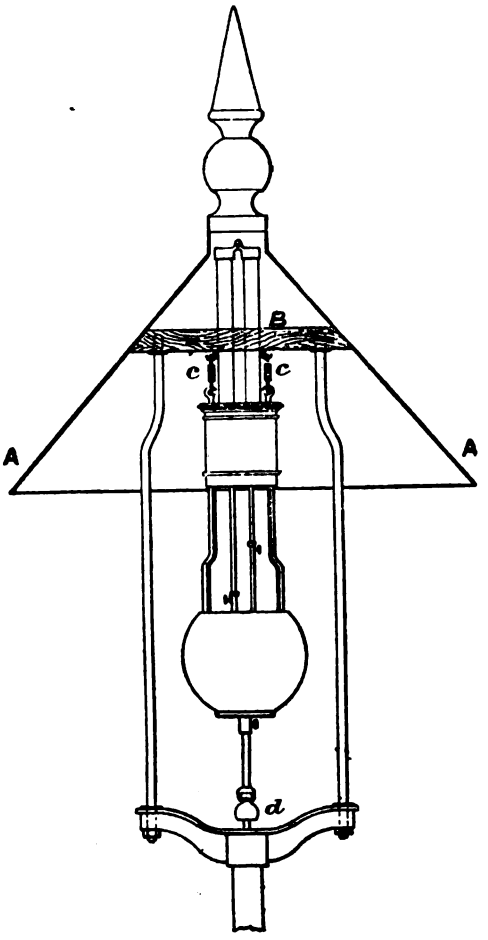

Fig. 4.

Where lamps are worked in series it will, in determining the circuit arrangements, be found desirable to ascertain the period during which the lights are required for use, and to group them accordingly, so that they may be turned off and on in sections, if possible, from the switchboard in the dynamo or transformer room. The groups should also be so arranged that, combined, they may equal the capacity of a machine. The circuits applicable to indoor lighting should be so arranged as to admit of their being worked independent of the outdoor or yard circuits, the light being required indoors at an earlier hour than those out of doors. For incandescent work the wires are, as a rule, run in grooved casing of the orthodox kind. The casing and cover are fixed by the outer and not by the centre fillet; the object in rejecting the centre screw being to exclude the aid it would afford to any creeping of the current across the centre fillet, should leakage at any time arise. Under such a condition it is clear the screw in the centre fillet would largely reduce the resistance between the two wires—that it would, in fact, become a sort of "half-way house" towards the passage of the current, and tend to ignite the wood. The wooden casing as at present employed affords a convenient mode of dealing with the wiring of rooms; but in view of the description of casing which one not unfrequently sees employed, and, indeed, under any circumstances, it can hardly be regarded as a perfectly satisfactory mode. If an artistic rectangular casing or tubing of metal which would not readily melt could be produced at a reasonable price, it would no doubt prove exceedingly serviceable.

Apart from the points referred to, there is, in the application of the electric light to railway working, little of a sufficiently special character to call for further reference. Numbers of the fittings employed, switches, switchboards, controlling arrangements, etc.—most of which are made in the company's own shops—are to be found in connection with each installation; but in this the installations on the Midland do not differ from all other installations, inasmuch as most have one or more specialities peculiar to themselves. Any such specialities are best investigated on the spot, and the Midland Railway Company will at all times be pleased to afford facilities for an inspection of any one of their works. The question which will probably most interest railway companies is that of

Cost.

To lay down an electric lighting plant is probably more costly than to establish means for illumination by gas; but when we take into consideration the relative cost of working, the light derived from each source—light for light, or candle-power for candle-power—the advantage is so largely in favour of the electric light as to more than fully compensate for any larger first outlay which may be incurred. The tabulated statement (II.) will afford data with respect to the output and cost of working of several of the electric lighting stations on the

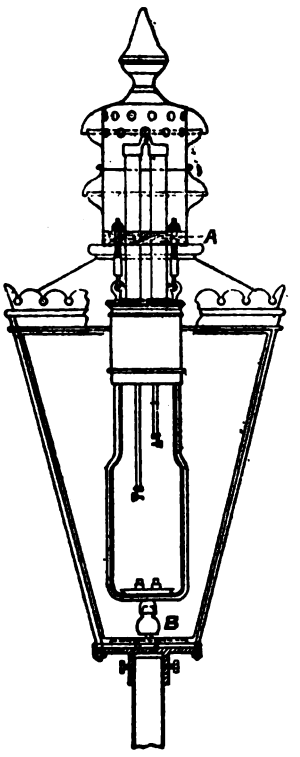

Fig. 5.

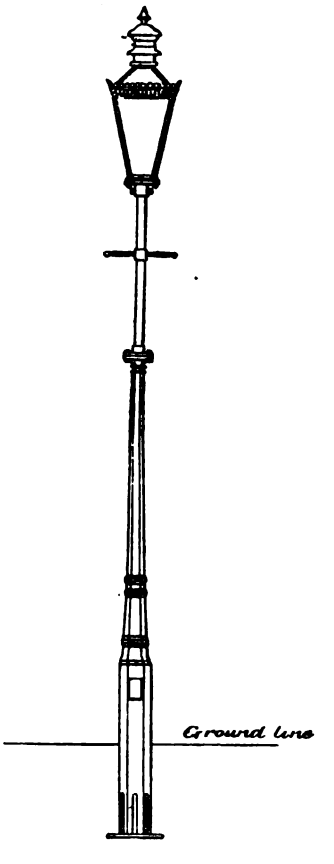

Fig. 6.

Midland. Certain charges for labour, engine and boiler repairs, and for coal, owing to charges for these items being combined with similar charges for hydraulic machinery located in the same building, it is possible, are not so strictly allocated as is desirable for a paper of this kind; still they are not largely inaccurate. They should, however, be regarded as maximum charges.

Nor are the charges in any case comparable with those of city supply stations. The arc lighting load, varying throughout the night according to traffic demands, is not so constant as that of a town service; while that for incandescent lighting lacks the continued evening service associated with town-lighting. At goods stations and for office lighting the latter rises to its maximum in the depth of winter for a period not exceeding an hour and a half daily—viz., 4 to 5.30 p.m.—while in summer the demand is still less. Still, the result, as compared with the cost of current obtained from a public supply source, is greatly in favour of an independent generating plant.

In criticising Table II.—viz., that of cost—we must also bear in mind the fact that the cost per unit carries with it the cost of carbons and carboning the arc lamps, together with cleaning, repairing, etc.; and that the cost for incandescent lighting also, as a rule, covers the renewal of lamps. The only exception rests with Bradford, where the lamps in the hotel are replaced by the hotel department, and their cost is not therefore included in the cost shown in the tabulated statement. Again, it should be understood that the appropriation of charges to incandescent and arc lighting, where both are in operation, is unavoidably somewhat

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TABLE II.—Midland Railway.—Electric Lighting.

Details of Cost, Half-Years ending June 30 and Dec. 31, 1894, including Maintenance and Renewal.

Installation.	Half-year ending	Total units.	Total cost.	Cost. Per unit, including all charges.	Per arc lamp hour.	Per unit for incandescent lighting.	Per unit for labour.	Per unit for material.	Per unit for repairs.	Per unit for coal.
			£ s. d.	d.	d.	d.	d.	d.	d.	d.
Somers Town	June 30	170,171	2,294 5 10	3·23	1·61*	—	1·15	0·65	0·29	1·00
	Dec. 31	187,326	2,506 6 4	3·20	1·60*	—	1·09	1·03	0·27	0·82
Bradford	June 30	82,984	1,115 15 0	3·23	1·39	2·7	1·19	0·56	0·47	0·80
	Dec. 31	100,388	967 5 6	2·36	0·98	2·0	1·06	0·56	0·18	0·44
Birmingham (Central)	June 30	70,774	950 10 11	3·22	1·60*	3·3	1·43	0·68	0·35	0·48
	Dec. 31	90,847	945 4 6	2·49	1·22*	2·7	1·03	0·64	0·34	0·37
,, (Lawley-street)	June 30	89,960	1,113 9 5	2·97	1·00	—	1·33	0·80	0·20	0·60
	Dec. 31	102,481	1,103 14 2	2·58	0·85	—	1·25	0·62	0·24	0·44
Hunslet	June 30	70,985	1,157 4 7	3·90	1·41	3·6	1·80	0·91	0·27	0·79
	Dec. 31	75,864	1,237 6 1	3·90	1·47	4·0	1·89	0·85	0·55	0·65
Derby	June 30	60,389	873 8 9	3·40	—	3·4	1·70	0·76	0·19	0·65
	Dec. 31	77,740	1,082 14 9	3·34	—	3·3	1·45	0·94	0·40	0·53

* These are 10-ampere lamps, 2,000 c.p. All others are 6·8 ampere, 1,200 c.p.

arbitrary. There are many items of cost which apply to both, such as labour in attendance upon the machinery, cleaning, etc. These have to be divided and appropriated as is considered fair and reasonable. The question will arise, is one favoured at the cost of the other? The result must speak for itself. Still one more condition! The output is obtained from records taken hourly, not from meter. The data are not, therefore, absolutely correct; but, taken over a period of 12 months, they are sufficiently reliable to afford a fair index of the cost.

Dealing with the table as it stands, we find the cost for arc lighting as under:

Depôt.	Cost per lamp per hour. d.
St. Pancras (Somers Town), 2,000-c.p. lamps	1·61
Birmingham (central goods), 2,000-c.p. lamps	1·41
,, (Lawley-street), 1,200-c.p. lamps	0·93
Leeds (Hunslet), 1,200-c.p. lamps	1·44
Bradford, 1,200-c.p. lamps	1·19
Total	6·58
Average	1·316

The lighting at Liverpool (Sandon Dock) and Sheffield has so recently been brought into use that returns from those depôts are purposely omitted. That at Wellingborough has only now started, and that at Nottingham is under construction. The daylight output for incandescent lighting at all of the arc lighting depôts is small. At Birmingham (central), where the lights are required in the bonding stores throughout the day, and at Bradford, where the demand applies to the hotel, station offices, and waiting-rooms, this is met by a gas-engine.

Some of the recently constructed goods depôts afford an opportunity for comparing the cost of the electric light with that of gas. Gas has been adopted as an alternative form of light in case of failure with the electric light. Consequently, the gas lighting was what might justly be regarded as modern gas lighting, affording an amount of light which, though not nearly so great as that afforded by the electric light, is greater than that which attained, and still attains, under the old system of gas lighting.

In the warehouses the gas lights are on the regenerative principle, and are each nominally 150 c.p.; the electric lights are arc lights, nominally of 2,000 c.p. It is officially stated that five cubic feet of gas, burnt under the principle referred to, will produce 25-c.p. light for one hour. There are 81 150-c.p. gas lights. The price of gas is 2s. 3d. per 1,000 cubic feet, less 5 per cent. On this basis, the cost of gas lighting would be 62d. per hour. There are 30 arc lights, the cost of which, as per Table II., averaged 1·41d. per light per hour. The total cost per hour would therefore be 42·3d., as against 62d. for gas, the relative nominal candle-power being—

Gas	12,300
Electric light	56,000

At Lawley-street, Birmingham, there are 53 arcs of 1,200 c.p., and, as an alternative, if required, 130 gas lights of 150 c.p. each. The arcs here average a cost of 0·93d. per lamp per hour. Gas is 2s. 3d. per 1,000 cubic feet, less 5 per cent. The result works out per hour—

53 arcs, affording 63,600 c.p.	49·29d.
130 gas, affording 19,500 c.p.	100·00d.

At Somers Town (New St. Pancras Goods) the gas used is manufactured at the company's own gasworks at Brent, near Welsh Harp, and is priced at 2s. per 1,000 cubic feet. The result is as follows:

29 arc lights, affording 58,000 c.p., cost per hour, 47d.
86 gas lights, affording 12,900 c.p., cost per hour, 61d.

If we extend these results so as to cover a period of a year—say, 3,000 hours—we have a saving of £1,050 per annum on the three ground floors of the goods warehouses referred to; and it is important to observe that whereas the charges for the electric light cover all charges—repairs, cleaning, etc.—the charge for gas is for gas pure and simple: there is no provision for cleaning or for repairs.

Gas Plant.

In the early portion of the paper reference has been made to a gas plant recently laid down at Leicester. This plant consists of four Crossley gas-engines, required to deliver under Dowson gas 40 h.p., and under coal gas 50 h.p., on the pulley of the dynamo, for the purpose of driving three 50-light 2,000-c.p. Brush series high-tension dynamos, and one low-tension dynamo employed chiefly for arc lighting; and two 14-h.p. nominal Crossley gas-engines required to transmit 25 h.p. to the pulleys of two Siemens incandescent machines. The service pipes are in duplicate—that is, one is in connection with the town gas, the other in connection with a Dowson gas plant. The engines are provided with valves which admit of the gas supply being changed over at will from coal gas to Dowson, or *vice versâ*. The object of this arrangement is to test the cost of gas as against that of steam. In construction, an ordinary gas plant saves the cost of boilers and chimney shaft and occupies less space, thereby effecting an economy in cost of building and cost of land. In maintenance there ought to be a saving in labour: no stoking is required when working off coal gas; and, as a rule, the attendance upon engines and dynamos is shared by the electrical attendants — engine-drivers and stokers are non-existent. Thus it would appear that there should, where coal gas only is used, be a saving of from two to three men. With a Dowson plant more space is occupied than if coal gas only is relied upon, and a man is also required for stoking and attendance upon generators. It remains to be seen if sufficient economy attaches to the employment of Dowson gas to compensate for the additional cost of plant, space, and buildings, and as regards maintenance, repairs, and labour.

The experience so far gained is scarcely sufficient to justify a definite expression of opinion, but the following test figures may be of some service. They should be accepted with reserve. The test extended over a period of four weeks during December, 1894, and it shows the following to be the cost of running, exclusive of repairs or renewals, but inclusive of carbons. Dowson gas was used during week-days, and coal gas on Sundays, or very occasionally:

Arc lights, 2,000 c.p.	1·2d. per lamp-hour.
Incandescent lights	2·3d. per unit.

It should be added that, although the output is not at its maximum—the whole of the proposed lighting not being yet established—the result here given is for a busy period. There will be periods during which the output will be much less, and consequently the result per lamp-hour not so good. As suggested, it is somewhat premature to attempt to draw a reliable comparison between this cost and that resulting from steam power; still, the figures are such as to inspire confidence in the experiment. At some future date the author will be glad to communicate the result of further experience.

Conclusion.

It is submitted that the experience so far gained establishes

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beyond doubt advantages largely in favour of the electric light as an illuminant for dealing with railway work wherever a large body of light is required. At the same time, we must be sensible of the fact that daily experience teaches us to look for further developments in the machinery employed; and although this does not necessarily entail replacement of existing plant, it is as well to mark well that which it is desirable should be achieved. One improvement should be the abolition of belt driving. All driving should be direct from the shaft of the engine. The result will be less danger of interruption, less space, greater regularity. The speed of dynamo machines for arc lighting in series is now being brought within the compass of high-speed steam-engines. This accomplished, the propriety of direct driving for series, as well as series-parallel arc, commends itself to our consideration.

A further advance is to be looked for in the unification of the class of generator. At the present moment it is necessary, where series arc and incandescent lighting has to be provided, to lay down independent power and independent machines for each, or to drive the arc lights from alternating or transformed alternating currents. To drive arc lights on the series-parallel system for any material distance from the generating plant would entail so large an outlay in cable as to strongly militate against its adoption for such small plants as railway companies require. It would appear that what is needed is a generator the energy derived from which may be applied alike to incandescent lighting, arc lighting, or motive power—for the latter is an application which will have to be provided for. Is this to be most economically and most successfully met by an alternator or by a direct-current machine? Are we to look for help in this direction from "rectified" currents? If a system having for its basis one common generator can be established without too great a sacrifice in efficiency, small installations, such as would be of great service to railway companies in many busy centres, could then be brought within a more economical compass than is now the case. Three units—one for the light load, another for the full load, and a third of a similar capacity as spare—would probably meet the requirements of every depôt, whereas at present spare units for both arc and incandescent work are necessary.

For instance, at Birmingham (Lawley-street) the plant, when all is complete, will consist of six 50-light arc lighting machines and two incandescent machines. Now, if all this could be met by three generators—one for the light load, arcs, and incandescents combined, another for the full load, and a third as spare—the engine and dynamo space would be largely reduced, and labour and repairs correspondingly lessened. As opposed to this would be the cost of transformers and transforming-rooms. To help this we might possibly have reduced cost in cables, so that, regarded as a whole, provided that which is sought can be secured without too great a sacrifice in efficiency between the generative output and the production of light, or other means of consuming the energy, there would appear to be reason in regarding such an arrangement as highly favourable to economy.

Few, probably, will doubt that electrical energy is destined—and that at no distant date—to become a useful and economic agent at all important railway centres, not merely for lighting, but for traction and other purposes at present met by horse labour, hydraulic power, etc. In determining the ultimate design of generator and mode of working, this probable demand should be present to our minds, both with regard to the electrical system and the design of buildings for generating plant. That the demand for electrical energy will increase we may be sure, and our provision should in all cases be such as will admit of extension. Attached to this paper will be found copies of some rules and regulations in relation to restrictions, duties, and the management of electrical depôts such as are required for use on railways, which experience has dictated, and which may possibly be of service to others. Appended are also some precautionary instructions which have been issued for the avoidance and treatment of accidental shock from electrical current.

USEFUL RULES FOR THE GUIDANCE OF ATTENDANTS AND OTHERS ENGAGED IN ELECTRIC LIGHTING DUTIES.

1. It is important that everyone who has any duty to perform in connection with electric lighting machinery and apparatus should bear in mind that the lighting of those buildings, yards, etc., to which it is applied is dependent thereon, and that the apparatus employed for the purpose must, as far as is possible, at all times be ready for use.

2. The foreman of every installation, or, in his absence, the leading man, must on the approach of fog, or darkness from other cause, get the machinery into motion and the lighting in operation as soon as possible, after satisfying himself that the lamps on the circuits are ready for use.

3. Where the lighting of the station, buildings, etc., is entirely dependent upon the electrical machinery, steam must be in readiness for use at any moment.

4. All machines, wearing parts, belts, circuits, etc., are to be carefully tested and examined when shut down, so that any defect may be at once rectified.

5. One hour prior to the usual time for starting, the attendants in charge of engines and dynamos must carefully test and examine all parts of the machinery, circuits, etc., under their charge, and satisfy themselves that all is in good working trim and capable of carrying on the run for the time required. If any doubt should arise, the machinery must be started at once, in order that its condition may be practically tested.

6. Should anything transpire which may prevent the lighting, immediate notice must be given to all whom the absence of the light will affect, and particulars of the cause must be reported by telegraph to the divisional superintendent.

7. When necessary to change over from one set of machinery to another, or from one machine to another, every effort must be made to effect the change without interrupting the lighting more than is absolutely unavoidable.

8. The foreman in charge of the installation will be held responsible that a sufficient stock—not less than one month's supply—of oils, carbons, and all other necessary stores is kept on hand.

9. The inspector or foreman—or, in his absence, the senior man in charge—will be held responsible for the due and efficient performance of the duties of his staff. He is required to appoint the duties and rounds of the dynamo attendants, trimmers, cleaners, etc.; to see that those duties are faithfully and strictly carried out; that all parts of the apparatus are kept in perfect working order; to take every step in his power to ensure the successful working of the machinery and apparatus entrusted to his care; and to bring under the notice of his superior officer without delay any neglect of duty.

10. Smoking when on duty is strictly prohibited.

11. Attendants, trimmers, and others are required to sign on and off in the duty-book provided for that purpose.

12. Hot carbons when removed from a lamp are to be placed in a receptacle safe from fire. Any man throwing a hot carbon to the ground will render himself liable to instant dismissal. The ends of all burnt carbons must be collected and brought back to the engine-room.

13. Foremen and trimmers are to satisfy themselves that no possibility exists of burning particles falling from or passing out of the lamps.

14. Open lights are not to be used in goods sheds, depôts, or elsewhere, without special sanction from the senior officer of the installation.

15. All lamps employed in goods warehouses, sheds, or other covered spaces or rooms, are to be taken down and thoroughly overhauled at periods not exceeding six months in duration.

16. Whenever steps or ladders are required for use in public roadways, sidings, or lines of railway, every precaution in order so avoid accident by or to passing vehicles or foot passengers is to be adopted. If necessary, a man is to be posted at the foot of the steps or ladder to protect the man standing thereon, and warn approaching foot passengers or vehicles.

17. All men employed, whether trimmers or others, are required to take every precaution to avoid the possibility of accident to themselves or others. Anyone who may be called upon to deal with apparatus through which the electric current is at the time passing, or during such time as there may be a risk of the current prevailing, is to use sound indiarubber gloves.

18. Each trimmer on completing his section is to report the same personally, or by telephone where such is provided, to the engine-room.

19. No circuit is to be brought into operation for lighting or other purposes until it has been ascertained that the trimmers and all workmen are clear from it.

20. Workmen, when going off or coming on duty, are required to leave the premises by the route indicated by the officer in charge of the installation—and which is to be that route which will afford the most proper means of reaching the public street or roadway without crossing working lines of railway.

21. Disregard of instructions, neglect of duty, or incivility, will in all cases be severely dealt with.

Dynamo-Room.

22. The dynamo-room must always be clean, and everything in its place ready for use.

23. Immediately a machine is shut down it must be cleaned and prepared for further use in case required, and covered up till needed.

24. All machines, circuits, and part of apparatus must be tested when shut down, and an hour before being started. Where incandescent machines are kept running for several hours, the machine, as also the circuit, may be tested for earth during the run; but such tests are in all cases to be made through a "resistance" approved for the purpose by the superintendent, and as may be directed by him.

25. Where the frame of a high-potential machine is insulated from the bed-plate, daily tests are to be made in order to ascertain if there exists any leakage from the coils or other parts of the machine to the frame from which it is insulated. If such

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is found to exist, those attending it are to be personally warned, and a notice in writing affixed to the machine cautioning all whom it may concern. The cause of the leakage should be traced and removed with all possible despatch.

26. Any difficulty which may present itself—loss of insulation of wires, or in the machine—is to be immediately reported to the superintendent.

27. Before starting, all binding screws and bolts should be examined. If a binding screw is loose, its surface should be examined. If found to be burnished, a fresh surface should be provided.

28. A diary and a duty-book are to be kept at each depôt. In the former is to be entered, by the chief attendant in charge, the condition of matters generally when leaving and when coming on duty, together with any circumstances which may have occurred during his duty, such as changes in the machines, irregularities of any description, details of the run, etc.

29. Iron and steel tools should be kept clear of all machines. Metal work must not be filed in their immediate neighbourhood. A copper oil-feeder with an insulated nozzle should be employed for lubrication. Oil or water must not be spilt upon or near any machine.

30. Any instructions which may be given by the superintendent with respect to the manipulation of switches, pressure of current, or changes to be effected, are to be most scrupulously observed.

Midland Railway.—Electrical Department.

Precautionary Instructions in Relation to the Avoidance of, and for the Treatment of Sufferers by, Accidental Shock from Electrical Current.

1. If ordinary precaution is observed in handling the electrical cables, wires, or apparatus, no danger need be apprehended; but where indifference to well-known restrictions, or negligence in any form, is allowed to prevail, serious consequences may ensue, not only to the individual guilty of such negligence, but to others who may be associated with him in the discharge of his duty. Regard any apparatus with which you may have to deal as capable of affording a shock, and adopt precautions accordingly.

2. No person should be entrusted with the performance of a duty until he is perfectly competent to deal with it.

3. When it is necessary for regulation or other purposes to touch parts of such apparatus when the current is active, the individual should be careful that his entire person is insulated from the earth, and from anything, other than an insulating medium, which connects with the earth. This may be best achieved by standing on an indiarubber mat. On no account should he touch parts of the machinery, cables, or apparatus with both hands at the same time, unless his hands are protected by sound indiarubber gloves. Shoes with indiarubber soles may be worn as an extra precaution, but the wearer must never rely upon them for insulation. Dynamo-room men should keep such shoes in the dynamo-room, and not wear them indiscriminately in and out of doors. The soles should be examined daily in order to ascertain that they are sound and dry.

4. The inspector and foreman of each depôt will be held individually responsible that a sufficient supply of indiarubber gloves are kept on hand to replace broken ones, and that one or more pairs (according to the magnitude and importance of the installation) are retained in a closet provided specially for he purpose (and marked I.R. Gloves), so as to be readily ccessible at any time.

5. Workmen are required, after using the gloves, to return them to the officer in charge of the dynamo or distribution room, and that officer will be held responsible that all gloves issued to workmen are returned to the closet or otherwise accounted for by an entry in the diary.

6. Should a lamp require attention during the time the current is flowing, the lamp is to be switched out of circuit before being touched by the switch at the base of the lamp-pillar, where such is provided; otherwise by the switch on the lamp, which, it must be borne in mind, does not insulate the lamp.

7. In cases of accident where a man has become paralysed by the current and is unable to extricate himself (*a*) the first effort should be to switch off the current; (*b*) failing the power to do this, to divert the current from the sufferer.

8. The first instruction is easily effected where the accident arises within ready reach of the dynamo, distributing-room, or switch.

9. The second instruction requires careful handling on the part of the rescuer. He has to bear in mind that if he touches the sufferer with his naked hands—even by his clothing, if damp from rain or the perspiration of the body—he may be placing himself in the same dangerous position as he whom he desires to rescue.

10. It is necessary he should keep himself insulated from the cable or apparatus, and from the sufferer, as well as from the earth.

11. Time is of the utmost importance, and will probably not admit of running for gloves or indiarubber mats. An instant of time may, if judiciously employed, suffice to release the sufferer, and any dry article of clothing may serve as an insulator for that short period.

12. If a piece of wire of sufficient capacity—an iron rod or any form of conductor—is at hand, the rescuer should, first, connect one end of the wire or rod to earth, and, failing a better means, divest himself of his jacket or coat and use it to insulate his hands from the other portion of the wire or bar and the cable whilst he attaches it to, or places it in contact with, the cable (or whatever may be the source from which the current is passing into the sufferer). The attachment should be as near to that part which is in contact with the sufferer as is possible. This may divert the current to the earth and release the sufferer.

13. Whether it does so or not the rescuer should, with continued caution, proceed to remove him from the position in which he is placed. He must insulate his own person by standing on a dry board, dry clothing, a bundle of dry straw, hay, etc. He must protect his hands by interposing as many thicknesses as possible of his dry clothing between them and the sufferer, and in this way endeavour to withdraw or raise and insulate the sufferer from contact with the earth. When insulated, the current will cease passing through him, and the cable, etc., may be withdrawn from contact with him. In doing so the rescuer must exercise great care that he does not place himself in a position to receive a shock.

14. Where a man is receiving a current through his person by having placed one part of his person in contact with one portion and another part in contact with another portion of a cable, etc., thereby forming of his person a portion of the circuit, the most ready means of delivering him is by short-circuiting such portion of the apparatus immediately outside the points of contact with the sufferer.

15. In cases where a man has received a serious shock, and life appears extinct, efforts similar to those employed in cases of drowning should be made to restore animation. Recent experience has shown that the system known as the "Laborde" system has been very successful. The treatment is as follows:

16. Lay the patient on his back in the open air. Remove his neckcloth and unfasten his collar. Open his mouth, and, taking hold of the front part of the tongue with your fingers—either bare or covered by a handkerchief—very slowly draw the tongue forward and as gently let it go back again 16 times a minute. Be sure that the root of the tongue is acted upon and drawn forward. Continue this action until signs of reanimation are observable, which should be the case in from 10 to 20 minutes. The motion thus imparted to the tongue should be regular and rhythmical in both its tractions and relaxations. If, in attempting to seize the tongue, it is found that the jaws are closed and the teeth clenched, open them by the finger, if possible, or, failing this, by a wedge-shaped piece of wood, the handle of a pocket-knife, or anything of the kind that may be at hand. Keep them wedged open.

17. The object of the traction effort on the tongue is to reinflate the lungs, and by that means reanimate the body. The rescuers' efforts should not be relaxed at the first appearance of reanimation. Those efforts must be continued until there is sufficient indication that this has been secured to such an extent as to ensure regular respiration by the patient without artificial aid. The patient should then be wrapped in such clothing as can be readily got together capable of affording warmth, and removed to the nearest hospital, infirmary, etc., or to his own residence if at hand, and placed in bed between blankets, with warm-water bottles to his feet. A little brandy may be administered as soon as the patient is able to swallow, the object now being by warmth to promote the circulation of the blood.

18. Another system is as follows: Lay the patient on his back in the open air. Remove his neckcloth and unfasten his shirt. Make a roll of clothing or anything else at hand and place it under his shoulders. The roll must be sufficiently large to so support the spine as to allow the head to fall downwards and backwards. The patient's mouth should be opened and the tongue drawn out to free the throat. The rescuer, kneeling behind the patient's head and facing him, should then grasp his elbows and draw them well over the head of the sufferer so as to bring them almost together above it, and there hold them for some two seconds. He should then carry them down to the sides and front of the chest, firmly compressing it by throwing his weight upon them. After some two seconds the action should be repeated, and continued at the rate of 16 times per minute. Under this action the extension of the arms expands the chest walls, as in inspiration or taking breath, and if the throat is clear the air will rush into the lungs. When the arms are brought down to the sides of the chest, compressing it, the air is expelled as in expiration. The action must be regular and rhythmical, and energetically and tirelessly persisted in until the breathing of the patient has again become normal. It is possible that this may not be assured in less than an hour.

19. If an assistant is at hand, both systems may be employed

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at the same time, the tongue being drawn out as the arms are raised and allowed to go back as the arms are depressed, the combined action being as nearly as possible perfectly uniform.

20. The first opportunity should be taken advantage of, by the services of anyone within call, to obtain the presence of a medical man, who should, upon his arrival, be requested to take charge of the further treatment of the patient, the purpose of the foregoing instructions being to enable such restorative measures to be adopted as may be possible pending the arrival of a qualified medical practitioner.

21. It is to be understood that, although there is to be no hesitation in shutting down any machinery the movement of which for the time being may endanger life, it is important that the machinery should, especially where it is employed for the lighting of railway stations, thoroughfares, buildings, etc., made use of by the public, be set in motion again as rapidly as possible. It must not be forgotten that the sudden withdrawal of light from a busy passenger or goods station, or from rooms, offices, etc., may be attended with the most serious consequences ; and for this reason no time must be lost, should occasion ever arise for suspending the light, in reinstating it.

Before the preceding paper was read, the minutes of the previous meeting were confirmed. **Mr. R. E. Crompton** (the president) then suggested that the balance-sheet, which had been circulated among the members, should be taken as read. He then formally moved the adoption of the balance-sheet.

Mr. Aylmer having seconded the motion,

Sir David Salomons (the hon. treasurer) drew attention to one or two interesting points in connection with the financial position of the Institution. In the first place, he had mentioned two years ago that the Institution had a surplus of £200 in the form of furniture, which, if it were sold, might or might not realise anything. At present, however, they had net receipts amounting to £3,424 as compared with an expenditure of £2,601, leaving a suplus in cash of £823. As regarded the surplus assets they were valued at £10,712 in 1894, as against £9,459 in the previous year, so that the Institution was growing wealthier every year. The total value of the journals, library, and furniture amounted to something under £2,000. The Institution had invested and in other forms the sum of £8,712, and he thought they might congratulate themselves upon that fact. He added that since the balance-sheet had been issued £1,100 had been invested.

The motion on being put to the meeting was unanimously adopted without comment.

The paper having been read,

Mr. R. E. Crompton stated that they would all agree that the paper was highly instructive, and that they were glad to have it as an addition to the *Proceedings*. Among the points which might very well be discussed were the questions of series *versus* parallel systems of arc lighting, the proper height of the arc lamps, and the arrangement of the light bridge for the carrying of the arc lamps. It was startling to find a railway engineer coming forward with such a statement of the respective costs ; electric light engineers would not have dared to have put forward the figures in such a straightforward way. Then, again, there were the questions of steam *versus* gas plant, and belt-driven as against direct-coupled plant. It was to be regretted that the author had not referred to the subject of the transmission of power.

Mr. Fletcher, jun., of the London and North-Western Railway, asked the author whether in the second table he had included any charges for depreciation and interest on capital, and was answered in the negative. Proceeding, the speaker referred to an installation at the Waterloo Goods Station, Liverpool. In that case gas engines were employed, the gas costing 3s. per thousand. The plant, which had been running since October, comprised three 55-h.p. gas engines, driving three 36-unit dynamos. The distribution was on the three-wire system, and separate arc and incandescent circuits were used. As the meters were read every quarter of an hour, as compared with hourly readings mentioned by the author, the speaker considered that the figures were accurate. During the week they produced from 2,000 to 2,500 units, and they were able to do that at a cost of 2·28d. per unit, including all station charges, carbons for arc lamps, and renewal of incandescent lamps. The labour per unit was ·49d., engine-room ·09d., carbon renewals ·1193d., and gas consumed 1·476d. per unit. The cost per unit for arc lighting was ·203, and for incandescents 1·8d.; the depreciation worked out at ·4d. per unit. They therefore produced the current for slightly over 2¼d. per unit, including all charges. In conclusion, he mentioned that the number of lamps in the installation was 720 incandescents and 36 double carbon arc lamps.

Dr. Du Riche Preller observed that the author had not arrived at any definite conclusion as regards the cost in cases where town gas, Dowson gas, or steam was used as the generating power. From his own experience the speaker said that if town gas could be obtained at 2s. 3d. per thousand it was preferable to Dowson gas, if only for the reason that the first cost of installing the gas plant was saved. Concerning the intervals at which arc lamps were placed apart and the height of the lamps from the rails, he asked whether the author had ever tried arc lamps arranged from from 30ft. to 40ft. high. Experience of similar installations on the Continent showed that the universal rule was to place the lamps from 50ft. to 60ft. high, the distance between the lamps being between 80ft. and 90ft. He had no hesitation in saying that the best system for incandescent lighting was the alternating-current method. The speaker then described the three-phase system in operation at Dresden, which he stated was exactly as the author had mentioned in his paper. The economy given by the author was confirmed by the installations at Metz and Strassburg, and a saving of as high as 60 per cent., as compared with gas, had been found, the reason being that the cost of gas was 5s. per thousand. The speaker then referred to the rules given at the close of the paper in regard to the treatment of persons who had received shocks. Those rules were similar to those recommended by M. D'Arsonval. In this connection the speaker cited one or two cases where those rules had been unsuccessful, and then jocularly referred to some experiments of the effects of the electric current upon mice, guinea pigs, etc.

At this point **Mr. W. H. Preece** calmly suggested that the guinea pigs were directors, and some seconds passed before his meaning dawned upon the meeting—with evident amusement.

The discussion was then adjourned until next Thursday, the 4th April.

The following is a list of the candidates balloted for :

Members.—Albert Gay, 3, Quadrant-road, Canonbury, N.; Frederick Spencer, Oxford House, The Pleck, Walsall; Jacob Stöttner, the Electrical Company, Limited, Charing Cross-road, W.C.

Associates —William Gay Clarke, Paddockhurst, Worth, Sussex ; William Corin, 182, Devonshire-road, Forest Hill, S.E.; Henry M. Darrah, Hollypoint, Heaton Mersey, near Manchester ; Captain Frederick Dennett Falshaw, the Central South American Telegraph Company's Steamship "Relay," Callao, Peru ; Harry Stacey Howard, Casilla, 120, Lima, Peru ; Hilton Johnson, Great Northern Railway, King's Cross, N.; Walter Sydney Sharwood, Earlsbrook House, Earlswood, Surrey ; Herbert Edward Soper, Municipal Offices, Cheltenham.

Students.—Edward George Brown, 25, Stamford-road, Fulham, S.W.; Anthony Clark MacWhirter, The Faraday Electrical Engineering Works, Govan, N.B. ; John Charles Melvin Matthews, "Wykeham," Church Walk, Thames Ditton ; Charles Vernon Morgan, 27, Leabourne-road, Stamford Hill, N. ; David Wright Niven, The Faraday Electrical Engineering Works, Govan, N.B.; Frank Berkeley Wily, "The Knowles," Newton Abbot.

SUPERVISION OF PARIS CENTRAL STATIONS.

A scheme has now been practically completed by M Tavernier, engineer-in-chief of the town of Paris for the lighting of the promenades and for concessions on the public ways, for considerably extending the system of inspection of electric lighting in that city. The control of electrical and compressed-air companies was entrusted to this department of inspection in 1893, but this control has hitherto only been exercised from the point of view of the payment made to the town out of the amounts received by the companies possessing concessions. It has had nothing to do with the conditions of installation of apparatus and laying of mains. These conditions, in fact, which are imposed upon contractors with a view to the prevention of accidents, are not uniform throughout Paris. Each sector, or district, is provided with its own regulations, so that the rules prevailing in one part are not applicable in another. As a French contemporary points out, contractors have an interest in the elaboration of a single set of regulations for the whole city, so that in case of accident the responsibility may be clearly determined. When these regulations are approved, the supervision of installations and the proof of departure therefrom will be entrusted to the Service du Contrôl Technique de l'Eclairage Electrique. The new regulations are to be submitted to the Town Council for consideration.

Electrical Legislation in India.—The Central Union of German Manufacturers have addressed to the Union of German Electrical Engineers a communication referring to the Bill promoted for the regulation of electric light installations in the Bengal province. This Bill, to which we have previously referred, is now being considered, the union state, from the point of view as to whether the legislation should be made to apply to the whole of India. In view of this fact, and as numerous applications for concessions are now being made, the union urge that German firms should endeavour to secure a share of the work likely to accrue through the development anticipated from the passing of the Bill. Important firms or agents in this branch, the union conclude, are unknown, and no results can therefore be expected through enquiries being addressed to the German Consulate in Calcutta.

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CODES.

Telegraphic codes have been born by the necessities of modern commerce. That, again, has undergone a revolution because of submarine cables, connecting all the great centres of trade of the world. The principal cable ring started and supports a technical paper to enlighten the public upon the truths of cable work; but by a freak on the funny side of nature this heavily-aided journal scarcely ever deigns to recognise the existence of cables, or the necessity of certain policies in cable management. Perhaps the ring has nothing to gain by publicity, or it may be that by the sad irony of fate the said journal is run by a staff to whom cable work is an unknown field. No doubt the staff is able to record a jaunt about the Mediterranean by the figure-head of the ring with his friends in a ship provided for the purpose by the company, but hardly to find a valid excuse for such proceedings. When, too, we come to the more recondite matter of a code or codes, the public is not enlightened as to the necessity of not allowing an indiscriminate selection of words. On the matter of codes, Mr. J. Henniker Heaton, M.P., whose constant criticism of the Post Office has led to so many improvements, according to the *Times* writes as follows to a Liverpool correspondent: "In the *Times* of the 16th inst. you will find the Postmaster-General's answer to a question of mine on this subject, his view being that our hands are tied by our connection with the Postal Union. This is only another proof of the recklessness with which the interests of British trade are signed away by our amateur diplomatists at the Post Office. The cables are in British hands; the bulk of the world's trade in which cabling is required is in British hands; yet British merchants are not consulted in the matter. It is well known that a code cannot be too extensive, since the larger the number of words the greater is the choice of expressions denoted by them. Accordingly, hitherto merchants have been allowed to take words from eight appointed languages, and many of them have been at enormous expense to prepare codes from these languages, embodying upwards of half a million words. Now the official vocabulary only includes between two hundred thousand and three hundred thousand words, so that the range of expression is greatly restricted, while the money spent on private codes is henceforth a great loss. I say nothing of the objections to the official list arising from the use of similar pairs of words, the want of an index, etc. My contention is that, if there is to be an official list, it should include all suitable words in the eight authorised languages, or that, in the alternative, private codes drawn from these languages should be admitted. Anything less would amount to a serious diminution of the utility of cables, and a corresponding injury to British trade. In my opinion, a deputation should wait on the Postmaster-General to remonstrate against the imposition of the official list; above all, for extra-European cablegrams."

We owe so much to Mr. Henniker Heaton that a little adverse criticism will do no harm, and a little

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commendatory criticism of cable management in this connection may do some good. Briefly, history will tell us that when the first cables were laid there were no codes. It will be seen, also, that eight languages may be used in the codification. The cost of cabling was soon found to be a heavy item in expenditure, and business men naturally wanted to reduce this expense. They therefore made up codes in which one word of code language may, when interpreted into ordinary language, stand for a whole sentence. With code-books in the senders' and receivers' hands, interpretation is easy, and so code messages soon took the place of ordinary language messages. For secresy, many merchants and manufacturers compile their own codes, and having eight languages to choose from, the result is a formidable total of words. Telegraphic signs are limited, and the indications on the recording instruments often feeble, and therefore difficult to read. The signs for many words of widely different signification are very similar, and so words may easily be mistaken. Without making this article too long, we may say at once we believe that the managers of the cable companies, whose initiation of a limitation to words to be used as code words must be granted, had but one object, and that beneficial to their clients. They wished to cast out all words that might be mistaken—and a cable mistake is often a costly matter—so saving expense. There are words so out of the way and so little used in the ordinary written or spoken language of these eight languages, that they ought not to be used as code words. A telegraph clerk is not a walking universal perfectly accurate dictionary in eight languages, and he often has to make a shot at the word intended to be signalled. If that word is an ordinary one, the chances are in favour of the correctness of the clerk; if a practically unused word, he may be at fault. Taking the few things we have said into consideration, and considering that, after all elimination, the compilers of codes have a quarter of a million, more or less, words to choose from, ought they not to be satisfied? We again reiterate—we believe it can be proved up to the hilt—that the labour of the selection of words has been taken primarily and mainly for the benefit of users of cables, to save them expense and possible error. To allow compilers of codes to use any word in the eight languages is simply to court expense and mistakes, and this an official list ought to minimise.

REVIEWS.

Elementary Lessons in Electricity and Magnetism. By SILVANUS P. THOMPSON, D.Sc, B.A., F.R.S, etc. New edition. Price 4s. 6d. Macmillan and Co.

This book is the recognised text-book in the majority of our schools and colleges, and, if from no other point of view, would therefore merit careful attention. But there are several other reasons why we should not only examine, but express our views upon this book. In the first place, no better exponent of current theories than the author can be found; but we entirely disagree with his teaching in the earlier lessons of this book. In our estimation he shows a woeful lack of intelligence, due to, so it seems to us, an attempt to run with both hare and hounds. But even when we disagree with the talented author, we have to confess his great ability and success in placing his matter before the student. In this notice our remarks will be chiefly confined to an examination of seven lessons, forming one chapter, some 80 odd pages in a book of over 600. With certain exceptions, our approbation of the book after Chapter I. is as emphatic as is our opposition to this particular chapter. Prof. Thompson will certainly understand our position, and we have no doubt will sooner or later acknowledge the correctness of our views by modifying his own accordingly. This is a book for the young student, and our endeavour is to make it as unattackable as possible. The rejection of schoolmaster's science when the student comes to practical work has gone on long enough. Prof. Thompson has supplied a mass of matter that cannot be rejected. This we admire. His style we admire, hence our hope that in one connection our adverse criticisms may be taken as friendly. In this book, as in all others, the author writes of and admits fully the idea of a "magnetic" and a "conductive" circuit. The surprise to us is that all his lessons upon induction are not based upon the "inductive" circuit. In these lessons upon "induction" he shirks principles, and leaves his readers to flounder hopelessly in the muddle of incompleteness. The acceptance of the "magnetic" and "conductive" circuit allows us to foretell the result of experiments. The non-acceptance of the inductive circuit leaves the student completely in the dark as to what the result will be under given conditions. Further, it necessitates a purely empirical method of treatment—a description of a lot of experiments that have no earthly connection in the mind of the reader, and are only connected when someone tells him that the results are in accord with a law as simple and as universal as Ohm's law is for the conductive circuit. We say this part of the book is incomplete, it suffers from omissions, and is far below the author's usual method of exposition. Let us give an example. § 63, page 75, is as follows:

"**Seat of Charge.**—Benjamin Franklin discovered that the charges of the Leyden jar really reside on the surface of the glass and not on the metallic coatings. This he proved by means of a jar whose coatings could be removed, Fig. 46. The jar was charged and placed upon an insulating stand. The inner coating was then lifted out and the glass jar was then taken out of the outer coating. Neither coating was found to be electrified to any extent, but on again putting the jar together it was found to be highly charged. The charges had all the time remained upon the inner and outer surfaces of the glass dielectric."

If the student is convinced by this so-called proof, we mistake the character of studentship. As Mr. A. J. Balfour points out in his admirable book on "The Foundation of Belief," this is just a statement made on authority and accepted without examination. We doubt, indeed, if Prof. Thompson himself ever gave a second thought to it. A doctrine accepted by everybody of any consequence, therefore authoritative, and to be accepted. Just for the sake of doing it, with the aid of the courteous principal of Messrs. Elliott's, St. Martin's-lane, we, the other day (March 26), carried out the experiments to corroborate the theory, as we think they ought to be carried out and described. In our case, we had two similar Leyden jars—Franklin pattern. One of these was charged by means of a Wimshurst machine. The outer and inner conductors of the charged jar were placed in position around the second glass jar, and it was found that the combination was *uncharged*. The uncharged conductors of the second jar were placed around the glass that originally was in the charged combination, and it was then found that this combination was *charged*. Here we did not return the original conductors, so that they could play no part in the final combination, but used altogether fresh conductors. This experiment, we think, and not that described by Prof. Thompson, proves satisfactorily that the charges remain on the glass. In our case there is no appeal to faith in authority, and we confess to little liking for the continued howling of speakers and authors for students to "open their mouths and shut their eyes," and swallow all that the, for the most part, self-constituted authorities tell them. It is a disgrace to

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the second-rank science of to-day that it follows so servilely in the footsteps of authority. Let us have a little more freedom and look into statements, forming an independent opinion—it may be correct, it may be incorrect—without being ostracised for so doing.

It is all very well to credit authorities with this, that, and the other result, but there is far too much of this kind of thing done by Prof. Thompson, both here and in others of his books, and the credit is too frequently given to men whom we do not consider at all superior to others whom he and similar writers never by chance deign to mention. Another objection to the earlier pages of the book is the loading with description of obsolete apparatus. What does the young beginner want to know about "Henley's semaphore" or "the torsion balance"? except the latter is to lead to "the law of inverse squares," a law which is immediately said to be "only true when applied to the case of bodies so small as compared with the distance between them that they are mere points"—that is, applies to nothing in practice. In this part of the book we hold the diagrams to be wrong and the teaching useless. The static field between any two conductors is modified by several conditions, but all coming within the ken of a law similar to that of "Ohm" for the conductive circuit. On page 23, Fig. 16, for example, the reasoning only applies when the two balls are in a position impossible to obtain while we are human creatures and restricted to living on this earth. If a sponge is never put into contact with water it remains dry, and we are not surprised at the result. We are not surprised at the result when it is put into water. Just the same, we maintain that as we explain conduction, etc., by reference to the circuit, we must explain induction similarly, and should as little expect signs of electrification upon a conductor (Fig. 17) not in the inductive circuit as we should water in the sponge that has always been kept away from that fluid. There is no earthly way, or any other, of foretelling the results of induction except by reference to a circuit, and all these little fiddle-faddling experiments can be more and completely explained by such reference, and the results of any such experiments can thus approximately be foretold. Take, again, experiment illustrated in Fig. 19, page 28, and fancy the poor little elementary student asking, Why? He asks for bread, and he doesn't even get the proverbial stone—he gets no answer at all, and so it is throughout these first lessons. The last sentence in paragraph 31, page 38, provokes the question, Why is the distribution not uniform? but the oracle remains mute. But enough, we take it that in this first chapter of eight lessons Prof. Thompson has done what he rebukes others in his preface for doing—that is, taken his information from previous authors. As for the latter, and by far the larger, part of the book, Prof. Thompson has kept himself well abreast with the modern progress on magnetic and electrical matters, and, as we have said, has the happy knack of putting his matter in an easily understandable manner. We are not going to discuss the details of these chapters: they are extended, rewritten, and rearranged where the progress of knowledge required. The immense value to the student of a book of this kind causes us to regret exceedingly that we have felt bound to animadvert so strongly on the first chapter. For the most modern, the most complete, and, on the whole, the most satisfactory book for younger students, this book of Prof. Thompson's stands easily first. Altogether there are 14 chapters, divided up into 56 lessons, with appendices, questions, and a good index, though in the latter case we always prefer page to paragraph numbering.

St. Saviour's Baths.—These new baths, which are to be opened on the first day of next month, are electrically lighted. The work has been carried out by Messrs. Strode and Co., who have installed a Siemens dynamo, giving 120 amperes at 125 volts when driven at 900 revolutions per minute by a Marshall engine. The dynamo is used to charge a battery of 55 Johnson and Phillips accumulators. These supply about 237 lamps, or rather supply the number that are required to be switched on out of this total.

NEW GALVANOMETER.*

The galvanometer illustrated in Fig. 1 has been brought out by Messrs. Richard Frères, of Paris, for the purpose of meeting the requirements of a small, portable, and strong instrument for use in small installations. It is only 3in. in diameter. The instrument comprises a fixed part formed by a coil, B (Fig. 2), through which passes the current to be measured, and a soft-iron armature, E, movable round an axis. The directing force is produced by a horseshoe magnet, A. The latter is firmly fixed upon a copper plate by means of three screws. Upon this plate

Fig. 1.

and between the poles of the magnet is mounted the core of the coil, the wire of which has ends which terminate at the terminals, D D^1, serving for the taking up of the current. The movable part placed in the centre of the coil is arranged on an axis pivoting upon agates; it carries a toothed sector, S, engaging with a pinion, P. It is upon the axis of this pinion that is fixed the indicating needle, which moves upon the divided scale. All the parts are equilibrated, so that the position of the needle does not in any way depend upon the position given to the instrument. The divided scale is fixed on the outer face of the plate. The result of

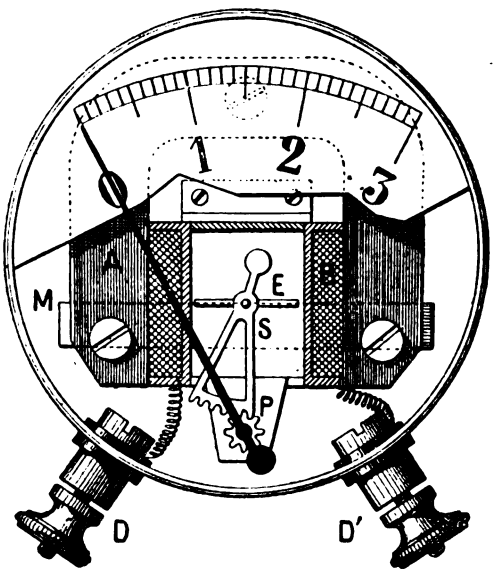

Fig. 2.

this is that it is only necessary to remove the bottom of the box by the withdrawal of three screws in order to see all the parts and ascertain whether everything is in order.

The working of the galvanometer is as follows: When the coil is traversed by a current it produces a magnetic field normal to that of the magnet; these two fields have a resultant which depends upon the intensity of the current, and according to which the movable part is directed. The angle of deviation is amplified by means of the toothed sector and the pinion, and we thus have a

* Abstracted from *L'Electricien*.

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great movement of the needle for a slight displacement of the movable part. The mechanical amplification possesses the advantage of bringing about sensitively proportional deviations of the needle, since the armature, displacing itself but little, remains in a nearly constant magnetic field. One of the principal characteristics of this galvanometer is the use of an armoured magnet, the armature being formed by a bar of soft iron, M. This bar is kept in position by a brass sheet resting upon two pillars fixed upon the plate of the galvanometer. By this arrangement a very small portion of the magnetism of the magnet is utilised as the directing field, and having its circuit closed this magnet has no tendency to lose its magnetisation. The bar in question can serve for regulating, for according to its position the magnet is more or less shunted, and a more or less powerful directing couple is obtained, this allowing of the sensitiveness of the instrument to be modified.

It will be seen from this description that the instrument can either be used as a voltmeter or ammeter according to the thickness of the wire in the coil, B; but it is specially suitable for use as a voltmeter employed in connection with primary and secondary batteries. For this purpose, the two types made are of three volts and five volts respectively; the former has a resistance of 100 ohms, and can therefore serve to measure currents up to 30 milliamperes.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 340).

In a very interesting paper entitled "On the Relation of the Air-Gap and the Shape of the Poles to the Performance of Dynamo-Electric Machinery," Prof. Harris J. Ryan has demonstrated the importance of making the pole-pieces of such shape that saturation at the pole corners cannot occur even at full load; for the armature ampere-turns cannot change the total magnetisation established by the field when the pole corners are unsaturated. He further proved by experiment that for a sparkless operation at all loads of a constant-current generator it is necessary that the air-gap be made of such a depth that the ampere-turns required to set up the magnetisation through the armature without current and for the production of the maximum E.M.F. of the machine shall be a little more than the ampere-turns of the armature when it furnishes its normal current. As long as the brushes were kept under the pole faces the non-sparking point was wherever the brushes were placed, no matter whether the armature core was saturated or not.

In order to enable currents to be taken from a machine at various voltages, W. B. Sayers has proposed to subdivide the pole faces by deep wide slots parallel to the armature shaft, Fig. 117, thus providing a number of neutral points on the commutator at which brushes may be placed without sparking. If, for instance, there are two such grooves in each pole-piece, the total voltage of the machine is divided into three equal parts, and by employing an intermediate brush at one of the additional neutral spaces, two circuits can be supplied by the machine—one each between the intermediate brush and one of the main brushes, one having two-thirds and the other one-third of the total voltage furnished by the dynamo.

45. *Base, Zinc Blocks, Pedestals, and Bearings—(a) Base.*—The base is the only part of the machine where weight is not only not objectionable but very beneficial, and it should therefore be a heavy iron casting, especially as the extra cost of plain cast iron is insignificant as compared with the entire cost of the machine. A heavy base brings the centre of gravity low, and consequently gives great stability and strength to the whole machine.

Besides this mechanical argument in favour of a massive casting, there is a magnetical reason which applies to all types in which the base constitutes a part of the magnetic circuit, as is the case in the inverted horseshoe type, Fig. 68, in the vertical single-magnet type, Fig. 73, in the inclined and vertical double-magnet types, Figs. 78 and 79, respectively, in the iron-clad types, Figs. 83, 85, 86, 87, 98, and 99, respectively, and in the vertical quadruple-magnet machine, Fig. 104. In these and similar types a heavy base of consequent high permeance reduces the reluctance of the entire magnetic circuit and effects a saving in exciting power which usually is sufficient to repay the extra expense involved, and often even reduces the total cost of the machine.

If the base forms a part of the magnetic circuit of the machine, constituting either the yoke or one of the pole-pieces, its least cross-section perpendicular to the flow of the magnetic lines should be dimensioned by the rules given for cast-iron magnets—that is, it should be at least one and two-third to two times the area of the magnet cores, if the latter are of wrought iron or cast steel, and at least of equal area if they are of the same material as the base—*i.e.*, of cast iron.

(b) Zinc Blocks.—In some forms of machines, such as the upright horseshoe type, Fig. 67, the horizontal single-magnet types, Figs. 71 and 72, the consequent-pole, horizontal double-magnet type, Fig. 78, the tangential multipolar type, Fig. 90, etc., the magnet frame rests upon two pole-pieces of opposite polarity; and if these were joined by the iron base the latter would constitute a stray path of very much lower reluctance than the useful path through air-gaps and armature, and the lines of force emanating from these two pole-pieces would thus be shunted away from the armature instead of forming a magnetic field for the conductors. In order to prevent such a short-circuiting of the magnetic lines, it is necessary either to use material different from iron for the base, or to interpose blocks of a non-magnetic substance between the pole-pieces and the bed-plate. The former method can be applied to small machines only, and in this case the magnet frame is mounted upon a base of either wood or brass. For large machines a wooden base would be too weak and too light and a brass one too expensive, and resort has to be taken to the second method of interposing a magnetic insulator, zinc being most usually employed. These zinc blocks must be of the necessary strength not only to carry the weight of the frame, but also to withstand the tremor of the machine, and must be made high enough to introduce a sufficient amount of reluctance into the path of leakage through the base. The reluctance required in that path must be at least four times, and preferably should be up to 10 or 12 times that of the air-gaps—that is, its relative permeance calculated from formula (114), chapter 38, according to the size of the machine, should range between one-fourth and one-twelfth of the relative permeance of the air-gaps as found from formula (126) or (127), chapter 39, the amount of leakage through the iron base being thereby limited to 25 per cent. of the useful flux in small dynamos, and to 8 per cent. in the largest machines.

This condition is fulfilled if the height of the zinc blocks, according to the kind and the size of the machine, is from three to fifteen times greater than the radial length of the gap space. The following tables, LIV., LV., and LVI.,

TABLE LIV.—Height of Zinc Blocks for High-Speed Dynamos with Smooth-Core Drum Armature

Capacity in kilowatts.	Diameter of armature core (from Table VIII.).	Height of winding-space (from Table XV.).	Height of binding.	Radial clearance (from Table XLVIII.).	Radial length of gap space.	Ratio of height of zinc block to length of gap space	Height of zinc blocks.	Approx. leakage through base in p.c. of useful flux.
	In.	In.	In.	In.	In.		In	Per cent.
1	3¼	·3	·03	·045	·375	5	1⅞	25
2	3⅜	·325	·03	·045	·4	5	2	25
3	4½	·35	·03	·045	·425	5¼	2¼	25
5	5¼	·375	·03	·045	·45	5½	2½	20
10	6	·4	·04	·06	·5	5½	2¾	20
15	6¾	·425	·04	·06	·525	6	3⅛	18
20	7½	·45	·04	·06	·55	6¼	3½	18
25	8¼	·475	·04	·06	·575	7	4	16
30	9	·5	·05	·075	·625	7¼	4½	16
50	10½	·525	·05	·075	·65	7¾	5	15
75	12½	·55	·06	·09	·7	8½	6	14
100	15	·6	·06	·09	·75	8⅝	6¼	14
150	18½	·65	·065	·125	·84	9	7½	12
200	22½	·7	·07	·16	·93	9¾	9	10
300	28	·8	·07	·16	1·06	10½	11	10

* From the *Electrical World* (New York).

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TABLE LV.—Height of Zinc Blocks for High-Speed Dynamos with Smooth-Core Ring Armatures.

Capacity in kilowatts.	Diameter of armature core (from Table IX.).	Height of winding space (from Table XV.).	Height of binding.	Radial clearance (from Table XLVIII.).	Radial length of gap space.	Ratio of height of zinc block to length of gap space.	Height of zinc blocks.	Approx. leakage through base in p.c. of useful flux.
	In.	In.	In.	In.	In.		In.	Percent.
1	7	·25	·03	·045	·325	8	2½	15
2	8	·25	·03	·045	·325	9	3	14
3	9½	·275	·04	·06	·375	9½	3½	14
5	11	·3	·04	·06	·4	10	4	12
10	14	·325	·05	·075	·45	11	5	12
15	15	·325	05	·075	·45	11	5	12
20	16	·35	·06	·09	·5	12	6	10
25	18	·35	·06	·09	5	12	6	10
30	20	·375	·07	·13	·575	12	7	10
50	24	·4	·07	·13	·6	13½	8	9
75	28	·425	·07	·155	·65	14½	9½	9
100	32	·45	07	·155	·675	15½	10½	8
150	36	·475	07	·18	725	16	11½	8

TABLE LVI.—Height of Zinc Blocks for Slow-Speed Dynamos with Toothed and Perforated Armature.

Capacity in kilowatts.	Diameter of armature core (from Table X.).	Height of winding space (from Table XVI.).	Radial clearance (from Table XLVIII.).	Maxim. radial length of gap space.	Ratio of height of zinc block to max. length of gap space.	Height of zinc blocks.	Approx. leakage through base in p.c. of useful flux.
	In.	In.	In.	In.		In.	Percent.
2	12	1⅛	3/64	1 1/64	3	3½	15
3	15	1¼	1/16	1 5/64	3	4	15
5	17	1⅜	1/16	1 7/64	3½	5	12
10	21	1½	5/64	1 11/64	3¾	6	12
15	23	1⅝	5/64	1 15/64	4	6¾	10
20	25	1 11/16	3/32	1 19/64	4¼	7½	10
25	27	1¾	3/32	1 23/64	4⅜	8	10
30	30	1 13/16	1/16	1 15/32	4½	8¾	8
50	36	1⅞	1/8	2	4¾	9½	8

TABLE LVII.—Comparison of Zinc Blocks for Dynamos with Various Kinds of Armature.

Diameter of armature core.	Height of zinc blocks.		
	Smooth armatures.		Toothed and perforated armatures.
	Drum.	Ring.	
Inches.	Inches.	Inches.	Inches.
3	1¾	—	—
4	2	—	—
6	2¾	2	1¾
8	4	3	2½
10	5	3½	3
12	5¾	4½	3½
15	6½	5	4
18	7½	6	5
21	8¾	7	6
24	9¾	8	7
27	11	9	8
30	—	10	8¾
36	—	11½	9½

give the value of this ratio, the consequent height of the zinc blocks, and the corresponding approximate leakage through the base for high-speed dynamos with smooth-core drum armatures, for high-speed dynamos with smooth-core ring armatures, and for slow-speed machines with toothed and perforated armatures respectively:

From the comparison of the above Tables LIV., LV., and LVI., it follows that the height of the zinc blocks increases in a nearly direct proportion with the diameter of the armature core, and that for the same armature diameter a smooth-drum machine requires a higher and a toothed or perforated armature machine a lower zinc than a smooth-ring dynamo. By compiling the results of Tables LIV., LV., and LVI., the above Table LVII. is obtained, from which can be seen that the heights of zinc blocks for smooth-ring machines are from 18 to 30 per cent. less than for smooth-drum dynamos, and those for machines with toothed and perforated armatures are from 11 to 20 per cent. less than for smooth-ring armature dynamos.

(To be continued.)

A NEW METHOD OF MEASURING ILLUMINATION.*

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

In almost all cases the object of artificial lighting is to provide a sufficient intensity of illumination upon the illumined surfaces. In practice, the illumination is generally required so as to permit some kind of work to be carried on. In any case, the character and intensity of the illumination will necessarily vary with the nature of the work. In a room in which reading only is to be done, it suffices if the proper illumination is obtained on the pages of the books—*i.e.*, on the reading tables, though the remainder of the room is comparatively dark. Where machinery is to be operated, the main light is generally required upon certain moving parts. In cases, however, where the character of the work requires the attendant to move about, or to observe some distant part of the machinery, a necessity exists for avoiding marked contrasts in the illumination of the room. Here it is clear that the use of a single source—such as an arc lamp—is undesirable, since, apart from the fact that it would produce a powerful illumination in its immediate neighbourhood, it would necessarily cause annoying shadows which could only be avoided by diffusing and scattering the light. It is evident, therefore, that in practice it is the illumination, rather than the luminous intensity of the sources, which is desired to be obtained and measured.

Although experience will enable the electrical engineer to determine the probable number and grouping of sources of light—such as incandescent lamps, which will be required to produce any desired illumination in any given space—yet it is well known that no rigid rule can be laid down as a safe guide in such cases, since the character and colour of the surfaces of the walls and ceilings will largely influence the illumination produced by a given arrangement of light sources. The question, therefore, as to whether or not a certain area is properly lighted cannot be decided so accurately from the number and grouping of luminous sources and their candle-power as it can from a method of actually measuring the quantity of light received per unit of area by a particular surface or surfaces whose illumination it is desired to know. In other words, the question at issue is not so much the photometric intensity of the sources of light and their distribution as it is the degree of illumination actually produced, and this question cannot be decided by the photometer, but requires the use of an illumination-measurer or illuminometer.

Suppose, for example, it is desired to illumine a billiard-room. Though experience must determine the number and position of the lamps, yet the commercial question as to whether or not the necessary illumination has been obtained upon the tables can best be determined, not by the number of separate lamps of a given candle-power, but by an actual measurement of the light received per unit of area on the table surfaces. In the same way, whether or not a certain grouping of lights over the tables is sufficient to illumine the rest of the room satisfactorily can be determined by the measurement of the illumination produced in different parts of the room. Similarly, in a dining or reading room it is the illumination of the tables that has to be specially provided for, and the question of proper lighting is best determined from a determination of the illumination of the tables, irrespective of the character or number of the lights present, except, of course, in so far as æsthetic requirements are concerned.

In street-lighting the requirements are that sufficient illumination be obtained on the surfaces of the streets, houses, vehicles, and persons, to be able to discern them clearly at reasonably sufficient distances. This primarily requires a certain intensity of illumination over a given area, and can best be determined from the actual measurement of the minimum illumination, rather than by calculations dependent upon a number of complex conditions, of which the photometrical intensity of the sources employed is but one.

Measuring the illumination rather than measuring the intensity of separate lamps would remove a source of great

* Paper read before the National Electric Light Association, Cleveland, February, 1895.

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annoyance, both to electrical engineers and to municipalities, by rendering unnecessary discussions as to the candle-power of incandescent or arc lights employed, since, if the contract between the city and the lighting company be so drawn that the illumination in any part of a lighted street, for example, in the absence of moonlight, shall not be less than a certain minimum, all questions as to the candle-power of the separate sources will fail to affect the contract, and it only remains for the electrical engineer to provide such lamps as will, at the spacing employed, give the illumination contracted for.

So far as we know, there is no actual apparatus in existence, other than that we are about to describe, that will directly measure the intensity of the illumination at a given point, except the portable photometer of Prof. Weber, described by Mr. Heinrich at page 422, vol. xi., No. 7, July, 1894, of the *Proceedings* of the American Institute of Electrical Engineers. In Weber's photometer the illumination received upon a screen from a small standard amyl-acetate or benzine lamp is compared with the illumination to be measured. The difficulty of obtaining a reliable portable standard lamp, the rather cumbersome size of the apparatus, and the fact that it does not obviate the difficulty of comparing illuminations of different colours, have led us to devise a new instrument based on entirely different principles. We call our instrument an illuminometer, and have filed applications for a patent on the same.

A certain intensity of illumination is required to render a definite object viewed at a definite distance clearly delineated to the eye. It is well known that the illumination received upon a printed page of a book or newspaper must have a definite value in order to render the printed characters legible, and that the intensity of the illumination so required will, for a normal eye, depend upon the size and character of the print.

We employ this principle in the operation of our illuminometer as follows: A small test object of, say, printed characters, is placed in a darkened box, sufficiently small to be readily carried in the pocket. The test object is exposed to illumination received from a translucent plate of porcelain or opal glass, which receives directly on its surface the illumination whose intensity is to be measured. Since the test object receives the light from this plate by tranmission and subsequent diffusion, it is the area of the translucent plate exposed to the test object, in order to just render the latter legible to the eye, that determines the intensity of illumination upon the plate. A focusing eye-piece is placed opposite the test object for purposes of annulling the effect of any focal abnormalities of vision. A sliding shutter, movable by a milled headed screw, permits the effective area of the opal glass plate to be reduced until the amount of light received by the test object just permits of its legibility.

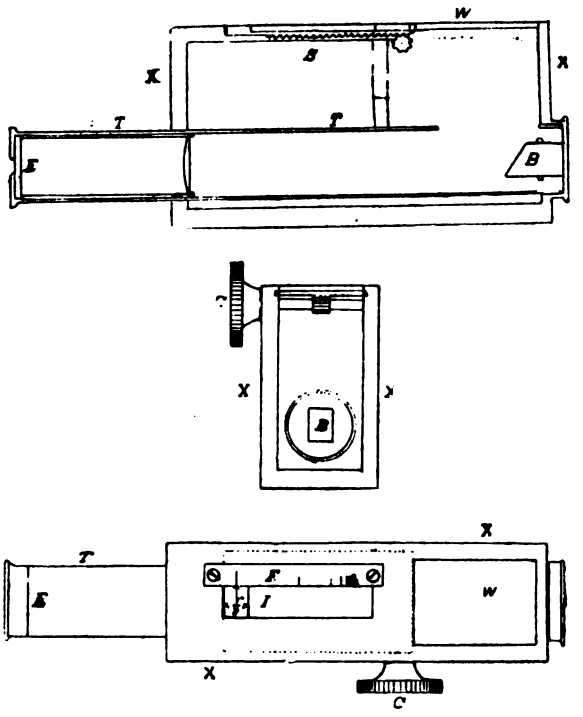
The detailed construction of our apparatus will be understood from an examination of Figs. 1, 2, and 3, which represent respectively a longitudinal cross-section, a transverse cross-section, and a plan view. A box, X X, blackened inside to prevent the reflection of light. is provided with a tube, T T, as shown. The test object is placed on a block at B, opposite the focussing eye-piece, E. At the top of the box is a window, W W, closed by a translucent diaphragm of porcelain, opal glass, or similar material. This diaphragm is placed so as to act as a secondary illuminator of the test object at B.

In order to regulate the amount of light which passes from the window, W W, to the test object, a sliding shutter, S S, operated from beneath by a milled headed screw, C, is placed in guides beneath the window, so as to cover any desired fraction of its surface. In order to determine the effective area of the window—*i.e.*, the uncovered portion which admits light to the test object, B, the index, I, attached to the shutter, moves over a calibrated scale, S, from which the amount of illumination on the window, W W, may be immediately read off in suitable units.

Calibration of the instrument is effected by exposing the window, W W, to known intensities of illumination in a photometer or darkened room, and marking off upon the scale, S, the points at which the indications of the instrument are obtained.

By the illumination on a surface is meant the quantity of light it receives per unit of area. Illumination may be expressed in terms of some unit illumination obtained from a definite source at a definite distance. Thus, a standard candle produces a definite illumination at the distance of a foot, and this illumination is sometimes called a candle foot. A less objectionable and more generally recognised unit is the illumination produced by an international standard candle at the distance of one metre and this unit is called the bougie-metre, or the lux.

The international standard candle above referred to is the *bougie decimal*, or the one-twentieth of the Violle, or molten platinum standard of light, adopted by the Paris International Electrical Congress of 1889. Authorities, unfortunately, differ as to the relative value of this decimal standard candle in terms of the British candle, or Sugg, which burns 0·1296 gramme per minute; but Everett in his C.G.S. system of units, 1891, gives data which make the international candle 0·988, or about 1·2 per cent. less than the standard British candle. Approximately, therefore, one lux is the illumination produced by a standard British candle at a distance of a metre.



FIGS. 1, 2, AND 3.

In employing our instrument for such a purpose, for example, as measuring the illumination upon the surface of a table illuminated by daylight, candle light, or incandescent light, we place the illuminometer upon the table with its window up, so that its window being only 2in. above the table practically coincides with the surface whose illumination is to be measured. The eye is then applied to the eye-piece and the test object focussed under the full illumination. The shutter is then gradually moved over the window until the test object just remains legible, when the number of luxes in the illumination of the table are shown by the index on the scale.

The degree of accuracy with which these measurements can be made, though small as compared with such determinations as length, mass, and time, nevertheless does not compare unfavourably with photometric measurements in general. It is well known that two observers may vary in their determinations of the candle-power of a incandescent lamp by 5 per cent, and, when the lights to be compared have different colours, the variation is often much greater.

The mean error of a single observation with our instrument is 10 per cent.—that is to say, if a number of measurements be successfully made of an illumination within the range of the instrument, the average deviation of any single measurement from the mean of all the measurements is, with the instrument here exhibited,

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about 10 per cent., although we believe certain changes we have in view will notably reduce this percentage. Such tabulated observations are appended. In the instrument exhibited, the graduation of the scale extends from four luxes by single luxes to 15, then to 35 in divisions of five luxes, then to 70 in divisions of 10 luxes, while the highest reading is 400. The total length of the scale is 1·5in. The total length of the instrument is 5½in., its breadth is 1·5, and its height, excluding the milled headed screw, is 2¼in., so that the apparatus can readily be carried in the pocket. Its weight is 10oz.

It might be supposed that two different observers, having different limits of distinct vision, would obtain different results in determining a given illumination by the use of our instrument. In point of fact, however, we find that by the use of the focussing eye-piece, distinct vision of the test object being readily secured for each observer, the results of different observers do not appear to differ by more than the limits of probable error for the apparatus.

It is known that an illumination of five luxes is sufficient to permit the reading of ordinary print, although, on physiological grounds, the eyes should not be used for continuous reading at illumination less than 10 luxes. Fifteen to 25 luxes may be regarded as proper artificial illumination for reading.

(To be continued.)

NEW AIR-SPACE INSULATED CABLE.

The growing demand for underground telephone and telegraph cables and the increase in the price of guttapercha have induced cable-makers to seek new means of meeting the requirements with as good results as have hitherto obtained, and particularly in regard to securing a capacity as low as possible.

In this connection the *Elektrotechnische Zeitschrift* points out that Mr. Franz Clouth, of the Rheinische Gummiwaarenfabrik, Cologne-Nippes, has introduced a telegraph cable which, independent from the expensive guttapercha, has a very low capacity and yet retains the usual diameter and ratio of weight. With a copper resistance of six ohms per kilometre at 15deg. C., the capacity amounts on an average to ·052 microfarad per kilometre, and the insulation resistance 10,000 megohms and above. The cable consists of seven strands which are surrounded by a double lead covering; it is wire armoured for drawing into pipes. The strands are insulated by means of cotton arranged round the wires lattice fashion. A three-mile length of cable of this type has been laid in Cologne. After laying, the electrical conditions were:

No.	Insulation in megohms.	Capacity in microfarads.	Resistance in ohms.
1	8,268	·053	5·98
2	9,500	·054	6·12
3	9,500	·053	6·22
4	9,570	·054	6·56
5	9,570	·054	6·28
6	9,850	·054	6·28
7	19,140	·043	5·99

The figures are per kilometre at 15deg. C.

THE RECENT EXPLOSIONS ON SOUTHWARK BRIDGE.

MAJOR CARDEW'S REPORT.

We give below the report, bearing the date of February 7, of Major P. Cardew concerning the series of explosions which occurred on February 1 on Southwark Bridge.

I have the honour to report that, in accordance with your instructions, I held an enquiry on the 4th inst., as detailed above. The City Solicitor represented the Trustees of the Bridge House Estates, the department of the Corporation vested with the care and maintenance of Southwark Bridge. Mr. F. Bailey, chief engineer to the City of London Electric Lighting Company, and Mr. F. Livesey, chief engineer to the South Metropolitan Gas Company, attended each on behalf of his company.

I append a transcript of shorthand notes of the evidence taken, kindly furnished by the Corporation of the City of London. Also a plan and section, marked A, showing the various pipes and manholes, etc., at the spot where the explosions appear to have originated and a tracing marked B, giving a plan of the entire bridge, and showing the street boxes in connection with the mains of the electric lighting company in which explosions took place; this also indicates the pipes, manholes, etc., at the south end of the bridge. In order to explain the occurrence of these explosions it is necessary to refer in considerable detail to these underground arrangements, which consist of:

First, a brickwork culvert covered by an iron grating, and used in connection with the surface drainage, which crosses under the roadway, terminating on the east side in a "dead end" under the pavement, but on the west side an iron pipe connected to the culvert passes through the side of the bridge, and is continued down to the river. This is shown in plan and section marked A and in tracing B. At each side of the roadway catchpits have been recently constructed, discharging by means of a short length of pipe, not trapped in any way, into the culvert. These catchpits have the usual iron gully gratings at the level of the road. Under the footway on the west side there is a manhole closed by a stone slab and giving access to the culvert. A 3in. cast-iron gas-pipe crosses about 6in. above the culvert in the roadway on the west side, as shown in plan A. This pipe bends at right angles and terminates in a "dead end," but a small service pipe is taken from it to a gas meter in a pit under the footway. From this meter a supply is given to the lamps on the west side of the bridge by means of a pipe led along the outside of the parapet. The pipes belonging to the electric lighting company pass along under the footway just inside the kerb. They cross over the culvert and over the 3in. gas-pipe, but under the small gas-service pipe. None of the electric lighting company's pipes, however, at this spot contain mains, these being led away from the two street boxes shown in tracing B, on the west side of the bridge through the parapet, and down the pier of the bridge in a large iron casing. On the east side of the bridge there are a large number of electric mains in iron pipes and in bitumen casing passing under the footway and over the culvert.

From the evidence given at the enquiry there appears to be no doubt that the first explosion occurred in the culvert under the pavement and roadway on the west side of the south end of the bridge. Several witnesses were positive that this explosion occurred first by an appreciable interval of time, and one of them, Mr. W. C. Palmer, could hardly have made a mistake on this point, as he was in a pony-cart close to the explosion, and the pony and cart had moved across the road before the second explosion took place. This first explosion was by far the most intense of all which occurred, many paving stones being completely shattered. One woman was reported to be rather seriously injured by the *débris*. It was immediately followed by three explosions in the street boxes of the electric lighting company on the opposite (east) side of the bridge. These street boxes I have marked *b*, *c*, *d* on tracing B. One woman and two men were injured by these explosions, one man being blown up about 6ft or 7ft, according to the evidence of a policeman. This man, however, was able to give evidence at the enquiry. The covers and frames of the boxes were broken, and the pavement displaced at each box. A slight explosion appears also to have occurred in the street box on this side marked *a*, but this was not sufficiently intense to displace the cover. The officials of the electric lighting company were on the spot shortly after the occurrence, and those of the gas company as soon as they could be summoned. They found both the gas-meter boxes full of gas, which was also issuing freely from the gully grating over the catchpit on the west side.

On opening the ground over the culvert a large crack was found in the 3in. gas-main, out of which the gas was coming in volumes. This crack extended about half-way round the pipe, on the upper side. There was also a longitudinal crack in the pipe at the same place, but this appears to have been an old injury, and to have so far rusted up that there was little, if any, leakage through it. The roadway over this gas-pipe was frozen very hard, and was practically impermeable to gas, but between the pipe and the grating of the culvert immediately below it the soil was very loose, and some vacant space seems to have existed. Thus the gas found easy access to the culvert. How it was fired cannot, I fear, be exactly ascertained, but I think I can confidently assert that it was not by means of the electric lighting mains As before mentioned, there were no electric mains in the immediate vicinity of the first explosion, and the empty pipes prepared to take the mains do not appear to have been in any way injured. These pipes, it is true, communicate at a distance of about 16ft. with a street box which contains electric mains. I examined this box, but found no signs of any firing of gas having take place within it. The voltmeter records of the electric lighting company show no trace of disturbance on the circuits at the time of these explosions, and as the mains in use were all concentric cables, the outer conductors of which were thoroughly connected to earth at the generating station, I do not think they are likely to have produced a spark. The fact that there was no explosion in the street boxes on the west side of the bridge is a further proof that the escaped gas had not penetrated into them, and in consequence that it could not have been fired by the electric mains.

It was stated in evidence that a match which had recently been alight was found in the catchpit communicating with the culvert, and this may possibly have fired the gas. I believe that in the case of firing by ordinary flame it sometimes happens that the gas burns quietly for a considerable time should it be in too great

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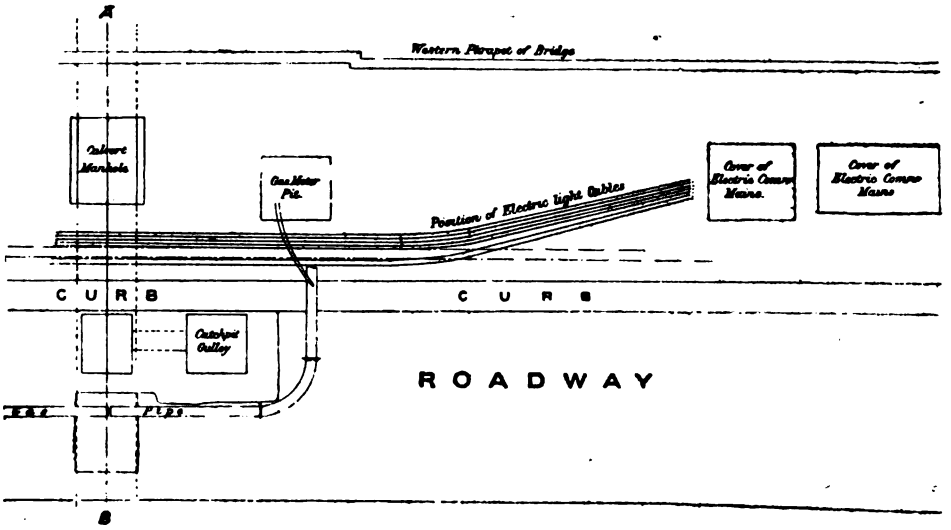
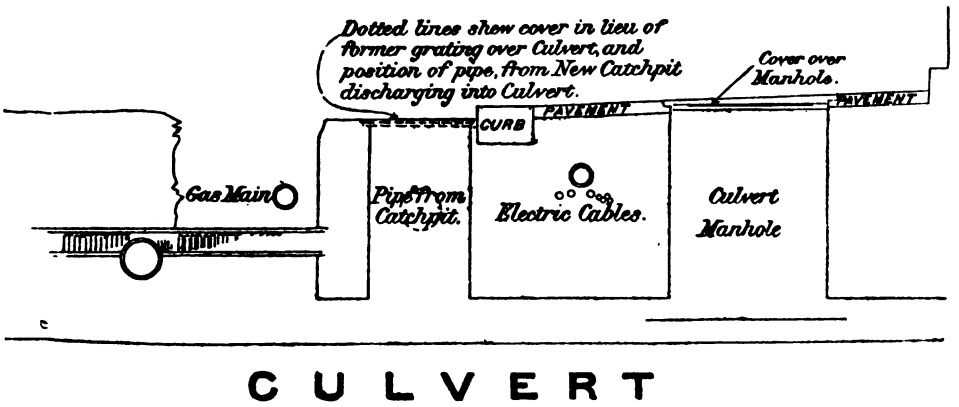
a quantity to form an explosive mixture, and that when the flame reaches a layer of explosive composition a violent explosion may result. It is, I think, quite possible this may have occurred in this instance, and that the person who threw the lighted match into the catchpit may be quite unaware that he thereby caused the explosion. The only other cause I can suggest is a spark struck by a horse's foot or a wheel close to the gully grating out of which the gas was issuing freely.

The explosion appears to have traversed the culvert and followed the course of the gas, which had percolated into the electric light street box, marked *a*, on the east side of bridge, whence it found its way by means of the pipes to those marked *b*, *c*, and *d*. The access to street box *a* appears to have been afforded by imperfect sealing round the pipes entering the box, which passed just over the culvert. This was tested by firing some smoke rockets inside this street box, when the smoke appeared in considerable volume at the culvert after about one minute, and seemed to be travelling along the outside of the pipes. Apparently on the west side the gas was unable to force its way into the electric light street box, but in this case the street box had only been constructed, and the pipes in connection with it laid, about a fortnight before the explosions occurred, and the pipes crossed at a greater height above the culvert.

attention in my report on the Cannon-street explosion in November last, greatly facilitates the passage of gas should it find access in considerable quantity at any point. This accident appears to me to suggest far more serious cause for anxiety than that which recently occurred in Cannon-street. It is true that in this case there was no electrical charging of the ground, or any defect in the electric lighting mains, and that the explosions were not due to any electrical action, but the Cannon-street accident was caused by a gross blunder on the part of the electric lighting company, and the company have since taken steps to make a repetition impossible.



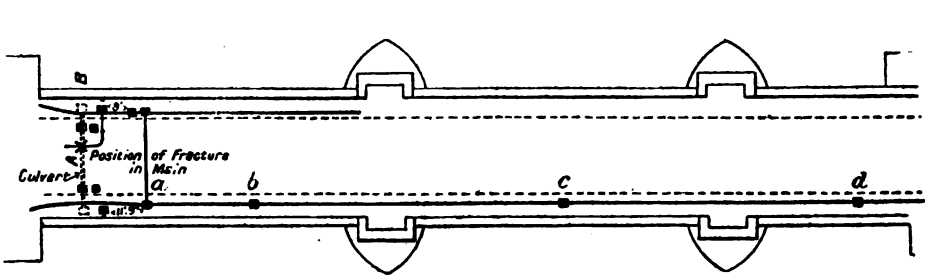
A.—Plan showing Pipes and Manholes where the explosions originated.



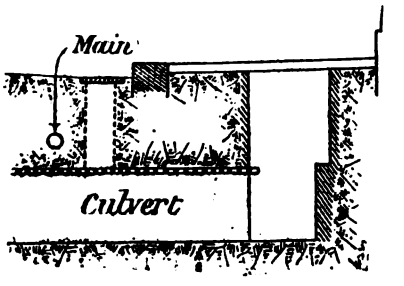
C U L V E R T

Section on Line A B.

The most striking features about the Southwark Bridge accident are: (1) the distance to which it appears that a series of explosions may travel along the electric mains which form a gigantic network under the whole of the streets of the City; and (2) the proof it affords of the insufficiency of any ordinary system of ventilation of these pipes and street boxes, if gas can find an easy access to them, and the necessity of exercising great care to make and keep the street boxes impervious to gas. The culvert which exploded in this case was provided by means of the catchpits and gully gratings with large openings for the escape of gas, and yet these did not prevent the explosion, and indeed probably enabled the accumulated gas to be fired. This culvert, however,



B.—Plan of Southwark Bridge showing Street-Boxes where explosions occurred.



Section on Line A B.

Having obtained access to street box *a*, the connecting pipes gave an easy passage to *b*, *c*, and *d*. As far as street box *c* the slope of the roadway favoured the passage of the gas, beyond that it was forced down the slope by the pressure from behind, and no doubt travelled more slowly. The explosion in *d* appears not to have been quite so violent as in *c*. Had more time been allowed for the penetration of the gas along the system of pipes, there is every reason to believe that more explosions would have occurred. The existence of numerous empty pipes in the system of mains laid by the City Electric Lighting Company, to which I called

so far from being impervious to gas, permitted it easy access through the openings of the grating forming the lid of the culvert.

After very careful consideration of the recent accident, I adhere to the recommendations as to prevention of accumulation of gas detailed in my report on the Cannon-street accident. Had these been carried out there would have been no explosion in the electric light conduits. I am, however, inclined to give more emphasis to the suggestion that the air capacity of the street boxes should be reduced by filling with incombustible material, and to add that unless and until an efficient system of ventilation by forced

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draught is provided, all the pipes and conduits should be thoroughly plugged at each street box (as recommended by Major-General Webber, C.B.).

With this addition I can only repeat the requirement No 7 of my former report: "Accumulation of gas should be prevented by thorough ventilation, by making the sides and bottoms of street boxes impervious to gas, and by filling up the boxes as far as practicable with incombustible material." To this I would now add "by thoroughly plugging pipes and conduits at each street box to prevent passage of gas along the system," and I put the filling up the boxes first, as the most simple and certain method of preventing danger of explosion. In cases where the street boxes are completely filled up it will obviously not be necessary to adopt the other precautions.

So far the electric lighting company have done very little towards carrying out this requirement. It appears that only 18 street boxes have been provided with ventilating-pipes, and these are not, in the cases I have examined, carried up at least 8ft. from the ground as recommended by me, but terminate a few inches from the pavement. The company have, however, protected the orifices with a cap and a screen of fine wire gauze, which may sufficiently guard against the danger of the gas issuing from these pipes becoming ignited by a match carelessly thrown near them. It must be admitted that in this case the main cause of the explosions was the defect in the gas-pipe, and it again directs attention to the very serious danger to the public arising from the condition of the gas pipes in many districts, and the way in which they are laid and supported—a danger which is continually increasing owing to the spread of the use of wood paving and other impervious surfaces, and which is temporarily intensified by every severe frost.

No remissness on the part of the gas companies can, however, relieve the electric lighting company of the duty of thoroughly complying with regulations (14) and (15) by sufficiently protecting their conduits and street boxes against an accumulation of gas. How this may be done I have already specified in this report and in my report on the Cannon-street accident, and I recommend that the Board of Trade should require the City of London Electric Lighting Company to at once take the necessary measures to fully comply with the regulations imposed upon them by the Board of Trade for the protection of the public safety.

THE SELECT COMMITTEE ON TELEPHONY.

The Select Committee of the House of Commons appointed to consider and report whether the provision now made for the telephone service in local areas is adequate, and whether it is expedient to supplement or improve this provision either by the granting of licenses to local authorities or otherwise, met on Friday for the first time to hear evidence, Mr. A. Morley (Postmaster-General) occupying the chair.

Mr. G. C. Lamb, assistant secretary of the Post Office, who was examined by the **Chairman**, said that the telephone was first brought to this country by Lord Kelvin in 1876, but then in a very crude form. In 1878 the discovery of the microphone by Prof. Hughes made the telephone a practicable instrument, and a company was started for acquiring and working Bell's patent. In 1879 it sought an alliance with the Post Office, but the negotiations came to nothing, and in the autumn of 1879 the Edison Telephone Company announced that they intended to establish telephonic exchanges. The first exchange of the kind had been established in Chicago in the previous year. The Post Office immediately pointed out that the proposed operations would infringe the Postmaster-General's rights, and an information was filed against the Edison Company and the United Telephone Company. In June, 1880, the two companies amalgamated under the title of the latter. The legal proceedings were concluded in December, 1880, when judgment was given by the High Court of Justice in favour of the Post Office. In anticipation of this judgment, the Post Office had made arrangements to establish telephone exchanges of its own. At the same time negotiations with the telephone companies were opened for granting to them licenses. The licenses were to be granted under what was interpreted to be the authority of the Telegraph Act, 1869. The companies in accepting the license certainly accepted the judgment. If they had thought they would succeed on appeal, they would have appealed. In April, 1881, the United Telephone Company was granted a license to carry on telephone-exchange business in London. The area of its operations was to be five miles from a central point selected by the company, and a royalty was to be paid to the Post Office. The policy of the United Telephone Company was to confine its own exchange operations to London, and to allow its patent rights to be used in other parts of the country by subsidiary companies, which negotiated themselves for licenses. The company had a practical monopoly of the best telephonic apparatus. Licenses were granted to provincial companies, and all of them were for 31 years from the date of the original license, and all would expire at the end of 1911. The Post Office also established telephone exchanges of its own in several additional towns, among others Cardiff and Newport. Up to that time there had been no trunk wires between the large towns, but in 1881 a few were provided by the Post Office at a fixed annual rate. The licenses were restricted to areas, and no company had power to construct trunk wires. In 1882 the London Globe Telephone Company applied for a license in London, and, though the United Telephone Company objected to competition, the license was granted, and in the same year the Postmaster-General granted licenses for the establishment of exchanges even in towns such as Newcastle, where the Post Office had exchanges of its own. In 1884 the London Globe Company was absorbed by the United Telephone Company. In July, after consultation with the companies, Mr. Fawcett sought the authority of the Treasury to abolish all restrictions of areas and to throw the whole country open to the operations of licensees. The arrangement was sanctioned in August, 1884; and, as a result, the licenses now held by the companies were given in substitution of the old and original licenses. They were terminable at six months' notice in 1907. The main difference between the "Fawcett" licenses and the original licenses was that the former were for the whole country, and authorised the erection of trunk wires. Altogether 23 licenses were granted, and at present 13 were in existence. But, as a matter of fact, all the companies holding those licenses had been absorbed either by the National Telephone Company or the New Telephone Company, and as the National Company held nearly all the shares in the New Company, which was now in process of liquidation, it might be taken that for all practical purposes there was only one company in existence. The late Government were led to consider the question of fresh arrangements by the public dissatisfaction with the service which the telephone companies were rendering, and by the alarm of the public at the uncontrolled monopoly which was gradually being created. They were also influenced by the repeated demands of the companies for further powers, and by the effect which the competition of the telephone companies was having on the telegraph revenue. In the six years 1886-91 the gross revenue of the companies rose from £261,000 to £465,000, while the net telegraph revenue was going down. In the year 1888-89 there was a balance of revenue over expenditure in the telegraph business of the country of about £88,000. In the following year that decreased to £85,000, and in the next year ot £68,000. In the year 1892 the balance of £68,000 was converted into adeficiency of £90,000. His own view was that that was largely due to the competition of the telephones. In 1886-91, while the business of the companies increased 77 per cent., the ordinary inland business of the Department increased only 44 per cent. The deficiency in the telegraph service for the year 1893-94 rose to £178,000, and it was estimated that in the year 1894 95 the deficiency would further increase to £240,000. He could not contend that the telephone competition accounted for the whole of that deficiency, but for a substantial part of it. The royalty paid in the year 1894 was £70,900; in 1891, £46,500; and in 1886, £26,100. The late Government did not see their way to purchase the companies' undertaking at the end of the first period mentioned in the license, which was 1890. After much consideration they adopted the policy set forth in the Treasury minute of 1892. Their intention was to facilitate the operations of the companies by conferring certain powers of constructing telegraphs enjoyed by the Postmaster-General; to give additional facilities to the public by a closer combination of the telephone systems with the postal and telegraph systems of the Post Office; to safeguard the interests of the telegraphs by erecting trunk lines between the different towns; and further to extend the trunk lines so as to bring into communication the most distant places in England and Ireland. The right of the Post Office to establish telephone systems was fully preserved. A Bill was introduced authorising the acquisition of the companies' trunk wires, and providing capital for the building of other trunk wires. Certain powers of wayleave were also conferred on the companies. This Bill became law as the Telegraph Act of 1892. In reporting to the House that the responsibility for the details of the agreement must rest with the Government, the committee made the reservation that the duration of the licenses should not be extended. The heads of the arrangement with the companies were signed in August, 1892. The Department had now expended about £374,000 on the erection of trunk wires It had completed the connection between Plymouth, Bristol, and the South Wales ports with Birmingham, Leeds, and Newcastle-on-Tyne. It had also completed lines from Hull to Leeds, and from Leeds to Manchester and Liverpool; from London to Chelmsford, Colchester, and Ipswich; from London to Brighton, Nottingham Derby, and Leicester; and from Edinburgh and Glasgow to Belfast and Dublin. Lines connecting London with Bristol, Southampton, and Portsmouth were in hand; and a main line from London through Nottingham, Sheffield, and Leeds to Glasgow would, it was hoped, be completed early next month. This direct communication between London and Glasgow, and consequently with the towns in communication with Glasgow, was something entirely new. In addition to this main system, about 50 lines of minor importance had been constructed or were in process of construction. Under the agreement the Postmaster-General took over the trunk lines of the companies, and would pay a sum to be fixed by experts, and the operations of the companies would be limited to specified exchange areas. The companies were to construct connecting wires from their exchanges to the post offices to enable their customers to make use of the public wires for the conveyance of telegrams and the delivery of express letters. For the working of these connecting wires the Postmaster-General made no charge, and he was to provide underground wires between exchanges situate in the same area. Further, he was to give permission to the companies to make agreements with the railway and canal companies over whose property he had exclusive rights of way for the construction by the companies of telephone wires, and they were to pay him merely a nominal rental of 1s. per mile instead of 20s. per mile as was before provided. This concession involved a reduction in the payments made by the company to the Department of about £2,400 a year. The power of the Postmaster-General to provide telephone exchanges, or to allow others to do so,

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was fully reserved. The result of the agreement would be that there would be a complete national system of telephonic communication throughout Great Britain, and between Great Britain and Ireland, and there would be placed at the disposal of the public facilities, not only for telephonic intercommunication, but for a combination of the telephone and the telegraphic and postal services of the State. The development of town intercommunication would be in the hands of the Post Office, and the development of the local exchanges would be in the hands of the companies. It was obvious that the taking over of the trunk wires by the Post Office was a step in the direction of the acquisition of the telephones. He believed that both reason and experience pointed to the necessity for only one exchange system within one area. As a matter of fact, every competing company that had been established had been absorbed by some existing company. It was obvious that, if efficiency and economy were looked for, only one system in one area should be provided. If those who used the telephone in any place were divided into two groups, those belonging to one group could not communicate with those belonging to the other, unless they subscribed to both systems. In Christiania they had two competing companies, and the municipality brought all its influence to bear on them to make them combine. There was no difference of opinion among experts that competing systems in one area must result in inconvenience to the public and in expense and want of efficiency. It was a fact that the deficiency in the telegraph revenue was arrived at after all the money for extensions had been paid out of the revenue of the year, excepting what remained of the capital provided by the Act of 1892. There had also been an enormous increase in the staff and in the wages of the Post Office during the past 10 years. Commercial depression would not affect the telegraph receipts more than the telephone receipts, but it was natural that the extension of telephonic communication should cause a diminution in telegraph receipts. The witness said that without any breach of honour or faith the Post Office could grant additional licenses. The Post Office had maintained the right to create competition.

BRAY (IRELAND) ELECTRIC LIGHTING BILL.

BILL OR PROVISIONAL ORDER.

The Bray Township Improvement Bill was considered by a Select Committee of the House of Commons last week under the presidency of Sir J. Kitson.

Mr. Hopwood, of the Board of Trade, said he had been asked to attend before the committee to make a statement of the views of the Board with reference to the application of the promoters to take electric lighting powers by the Bill rather than by a provisional order. He had no intention to oppose the promoters in any way, but the Board of Trade thought it their duty to lay before the committee the view which they had taken on this subject since the passing of the Electric Lighting Act of 1882. The Board held that electric lighting legislation was of a technical and quasi-scientific character. They admitted that the Act of 1882 contemplated that promoters might apply for powers by Bill equally with provisional orders, but they thought it would be much better to adopt a uniform system of provisional order legislation. It should be borne in mind that Parliament had an opportunity of expressing an opinion upon the terms of the Board of Trade orders when they came before Parliament for confirmation by Bill. The Board's provisional orders for electric lighting had been very carefully prepared, and they contained stipulations and provisions of all kinds to meet the requirements of different places and different sections of the community, and he might fairly say that a uniform system of provisional orders was now in force throughout the country. The question was whether it would be well to have, he would not say a dual control, but a dual procedure. The Board of Trade were quite prepared to admit that exceptional circumstances might arise in which it might be expedient to admit promoters to obtain powers of this description by Bill; in fact, there had been one such case in connection with a London company. So far as the present Bill was concerned the Board of Trade recognised that there were exceptional circumstances. It appeared that the promoters had exhausted their borrowing powers, and he took it that it would be impossible for the Board of Trade by order to enable the promoters to raise the necessary money to light Bray. On the other hand, it might be said that the circumstances were not sufficiently extraordinary to warrant a reversal of the ordinary procedure which had been adopted, because the promoters might very well apply to the House by this Bill for power to borrow money, and then go to the Board of Trade for a provisional order. Whether that would be looking at it from a purely business point of view was a question for the committee to decide. If the committee saw fit to recognise exceptional circumstances in this case he would ask them to impose the obligation on the promoters of making their Bill, so far as the electric lighting provisions were concerned, as far as possible, identical with the Board of Trade model orders.

Mr. Littler, Q.C., interposing, declared the willingness of the promoters to comply with that suggestion.

Mr. Hopwood said it would then really rest with the committee to say whether they thought that the circumstances there were so exceptional as to permit of the reversal of the policy which had been adopted up to the present time. He would also invite the committee, in case they came to the conclusion that the exceptional circumstances in that case justified the Bill, to say that it was not to be treated as a precedent. At present the terms of the Bill did not conform to the terms of the Board of Trade orders. For instance, there was no provision imposing a penalty for failure to supply. There was another question as to the area of supply. He gathered that a part of that area was outside the district of the Commissioners, and it was not quite clear how the promoters would deal with that matter, and what provision they would make for the protection of local authorities outside their own district.

Mr. Littler reiterated that the Commissioners were desirous of complying with the requirements of the Board of Trade, and if Mr. Hopwood would favour the promoters with a short interview he had no doubt they would be able to agree as to the form which the electric lighting clauses should take. If they found there was any serious difference between them they must refer the point to the committee, but he did not anticipate any such difficulty.

Mr. Hopwood expressed his willingness to consult with the promoters, and

The **Chairman** said the committee recognised that the circumstances were exceptional. The capital was very small, and it would not seem right to compel the promoters to go for a provisional order, which would probably cost them £300, or 10 per cent. on the amount they were going to give for the electric lighting plant.

Mr. Patrick M'Donnell, town clerk of Bray, said that by the present Bill the Commissioners were asking power to borrow £20,000 for the completion of the harbour, £6,000 for electric lighting, and £12,000 for the general purposes of the township. The electric lighting works at Bray were established three years ago. The Commissioners invited tenders for lighting the town, and Messrs. Gordon and Co. obtained the contract. Afterwards Mr. Gordon died, and the firm became insolvent. The Commissioners had now made a very good bargain with the liquidators to purchase the whole business, buildings, and plant for £3,060, but the agreement, which had been approved by the Court of Chancery, was conditional upon that Bill being pushed through this session. At present, although the public lamps were supplied with the electric light, very few shops or private houses had got it. They were afraid to go to the expense of having the proper fittings, etc, put in for fear the company should burst up, which it had done; but they knew that many householders were only waiting to have the electric light laid on until such time as the Commissioners took over the control and responsibility. The working expenses would be less under the Commissioners than they were under a private firm. Even if the consumption remained as it was, it was calculated that they would make £500 a year profit. The taking over of the electric light by the Commissioners was approved almost unanimously by the ratepayers at a town's meeting.

Witness was cross-examined by **Mr. P. Stephens** as to the correctness of his figures, and evidence was then called on behalf of the opposing railway company.

After the committee had consulted for some time in private,

The **Chairman** announced that the committee were agreed that the preamble of the Bill had been proved, but, having regard to the evidence of the town clerk that the general borrowing powers had not yet been exhausted, they wished to prevent those powers being further exercised. With regard to the electric lighting powers asked for, the committee agreed with the view expressed by Mr. Hopwood, on behalf of the Board of Trade, that in the absence of special circumstances such power should be obtained by provisional order, and not by Bill; but, recognising that exceptional circumstances existed in this case, the committee would report in favour of the powers asked for being granted, providing that the Bill followed as far as possible the terms of the model order of the Board of Trade, and that the concession in this case was not treated as a precedent.

Mr. Littler, Q.C., for the promoters, expressed their readiness to meet any suggestions the Board of Trade might choose to insert in the clauses.

The arrangement of the clauses in detail was postponed.

BRISTOL CORPORATION ELECTRICITY WORKS.

The accounts have been issued of the working of the electric light station of the Bristol Corporation during the year ended December 31, 1894. It appears that the expenditure during the past year reached £32,203, and that the total expenditure to December 31, 1894, has amounted to £82,186. Below are given the revenue account and balance sheet:

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1894.

A.—To Generation of Electricity.

Dr.	£ s. d.	£ s. d.
Coal, or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	1,529 18 7	
Oil, waste, water, and engine-room stores	185 17 1	
Wages at generating station	1,156 9 5	
Repairs and maintenance as follows—buildings, £9. 18s. 1d.; engines, boilers, etc., £147. 5s. 6d.; dynamos, exciters, etc., £2. 2s. 5d.; condensers, other machinery, instruments, and tools, £73. 17s. 1d; accumulators and accessories, £6. 10s. 1d.	239 13 2	
Removing ashes	35 0 0	
		3,176 18 3

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B.—To Distribution of Electricity.			
Wages and other remuneration to linesmen, fitters labourers	65 18 7		
Repairs, maintenance, and renewals of mains of all classes, including materials and laying same	1 2 5		
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	4 10 8		
Repairs, maintenance, and renewals of apparatus at distributing stations	7 2 9		
		78 14 5	
C.—To Public Lamps.			
Attending and repairs	342 8 0		
Carbons and renewals of lamps	236 12 10		
		579 0 10	
E.—To Rents, Rates, and Taxes.			
Rents payable	451 11 4		
Rates and taxes	682 12 7		
		1,134 3 11	
F.—To Management Expenses.			
Salaries—Engineer's department	376 12 10		
Secretary and clerical staff	285 4 4		
Stationery and printing	100 12 8		
General establishment charges	118 0 3		
		880 10 1	
G.—To Law and Parliamentary Charges.			
Law expenses, including stamp duty on mortgages of general district rate		198 17 .0	
H.—To Special Charges.			
Fire and boiler insurance, employer's liability, and fidelity guarantee premiums		53 4 5	
Advertising in art section of exhibition (current used)		66 8 0	
Total expenditure		6,167 16 11	
Amount carried to net revenue account		456 7 11	
		£6,624 4 10	

Cr.	£ s. d.
Sale of current, per meter, £3,545. 3s. 1d.; less discounts, £64. 1s. 3d.	3,481 1 10
Rental of meters on consumers' premises	159 9 4
	3,640 11 2
Less bad debts	8 3 0
	3,632 8 2
Public lighting	2,820 6 5
Incidents	1 10 3
Premiums received with improvers whose terms have expired, £200; less proportion to engineer for tuition, £30	170 0 0
	£6,624 4 10

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	90,000 0 0
Sundry creditors	728 4 1
Suspense account—balance	292 10 0
	£91,020 14 1

Cr. Assets.	£ s d.
Capital account—amount expended for works	82,186 3 5
Stores on hand, Dec. 31, 1894—coal, £34 2s. 3d.; oils, waste, etc, £31. 6s. 4d.; general, £58. 3s. 3d.	123 11 10
Sundry debtors for current, etc, supplied to Dec. 31	2,619 10 3
Net revenue account—balance at debit thereof	262 8 1
Cash in hand and at bank	5,829 0 6
	£91,020 14 1

LEGAL INTELLIGENCE.

BARCLAY v. THE NEW ZEALAND ELECTRICAL SYNDICATE.

In the Chancery Division of the High Court of Justice last week, before Mr. Justice North, a motion was heard for the appointment of a receiver and manager of the business of the defendant company, the plaintiffs being the holders of the whole of the debenture issue.

Mr. Stewart Smith said he appeared for the company, and submitted to the order.

Mr. O'Leigh Clare claimed to appear for the company, and objected to the order, his point being that the two directors for whom he appeared were the only real representatives of the company, and that they had commenced an action in the Queen's Bench Division to restrain the gentlemen who were instructing Mr. Smith from acting as directors on the ground that they had transferred their qualification shares before they attempted to act.

In support of the motion, **Mr. Swinfen Eady** said that the plaintiffs had £30,000 of debentures, which were charged on the undertaking of the company. The debentures were not in terms due; but the case made was one of great jeopardy, because unless the appointment asked for were made, the valuable concession and plant of the company might be forfeited.

Mr. Justice North made the order asked for, referring the matter to chambers for the appointment of a particular person, but appointing Mr. Barclay, the first plaintiff, interim receiver.

Later in the day, in the same matter, as Mr. Justice Kekewich was sitting, **Mr. Leigh Clare** asked for leave to serve short notice of motion for Tuesday for an injunction to restrain the two alleged directors from purporting to act in that capacity.

His **Lordship** said he would give leave to serve notice of motion for next Friday (to-day), with leave also to amend the writ asking for an alteration of the register.

WISE v. METROPOLITAN ELECTRIC SUPPLY COMPANY.

This case came before Mr. Justice Stirling in the Chancery Division of the High Court of Justice last week. It was a motion for a writ of sequestration against the company for alleged breach of an injunction restraining them from carrying on their business in such a way as to cause a nuisance to the plaintiffs by vibration. The plaintiffs are lodging-house keepers residing in the neighbourhood of Manchester-street, and their case against the company is that the vibration caused by the electric lighting machinery is such as to constitute a serious nuisance and injury to them. The injunction was granted in April last, but its operation has from time to time been suspended in order to give the defendants the opportunity of abating the nuisance by means of alterations in their machinery and otherwise. The last occasion on which the case came before the Court was in November, 1894, when the company gave an undertaking not to use more than one reciprocating engine in addition to certain steam turbines which had been substituted for the original engines. The plaintiffs now alleged that the nuisance still continued, and they pressed for the issue of a writ of sequestration.

Mr. Hastings, Q.C., and Mr. Beaumont appeared for the plaintiffs.

Mr. Waggett (who, with Mr. Vernon Smith, Q.C., appeared for the company) contended that this was not a case for the exercise of so extreme a remedy as the issue of a writ of sequestration. There was evidence that the nuisance was much abated and that the vibration was now very slight, if it existed at all. If the plaintiffs were asking for an injunction on the present evidence it would not be granted, and still less would the Court make an order of sequestration. The company had ordered two additional and improved turbines, which would be delivered in June, when the company would be able to dispense with the reciprocating engine altogether.

Mr. Justice Stirling said that the vibration was clearly much diminished, but it appeared to be still perceptible at times. He thought that when it did occur it was caused by the use of the reciprocating engine. There was no evidence before him that it impossible for the company to carry on their work without the use of that engine, and instead of ordering a writ of sequestration to issue he should put the company on terms not to use the reciprocating engine, and they must pay the costs of the motion.

COMPANIES' MEETINGS AND REPORTS.

W. T. HENLEY'S TELEGRAPH WORKS, LIMITED.

The annual general meeting was held last week at the offices, 27, Martin's-lane, Cannon-street, E.C., Mr. Sydney Gedge presiding.

The **Chairman**, in moving the adoption of the report (which was published in our last issue), congratulated the shareholders on the satisfactory result of the past year. He said that they were doing a steady and increasing business. Not only had the business increased, as compared with the previous year, but the ratio of profits had also advanced. The reason why they were able to sell at low prices and get better profits was because their works were well managed. The directors had now written off the shares they held in the International Cable Company, which amounted to £48,200, and he was happy to say that a substantial sum was expected from that source. The whole of the share capital had now been placed. The result of the year's working was a net profit of £16,455. After paying the expenses of issuing the debenture stock and the dividend on the preference shares, there remained £15,957. Out of that the directors proposed to add £2,180 to the reserve fund, to pay a further half-year's dividend on the preference shares at the rate of 7 per cent. per annum, a dividend on the ordinary shares of 7 per cent. per annum, and carry forward £8,624. During the current year the business of the Company showed a satisfactory increase.

The motion was seconded and carried.

Mr. R. J. Jenkins, C.E., and the Hon. Randolph Stewart, who retired by rotation, were re-elected directors, and a vote of thanks to the chairman and Board closed the proceedings.

EASTBOURNE ELECTRIC LIGHT COMPANY, LIMITED.

Directors: George Boulton (chairman), James George Langham, James Arthur Skinner, Harry Sutton. Manager, Henry Wall Wilkinson, A.M.I.C.E. Secretary, Henry Towner.

Report of the directors presented to the shareholders at the ordinary general meeting of the Company.

The directors have to congratulate the shareholders upon the

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extremely satisfactory progress of the Company. At the close of 1894 the number of lamps in circuit was as follows: arcs, 35; incandescents of an average of 8 c.p., 12,056—an increase for the year of eight arc and 2,179 incandescent lamps. The gross earnings for the year amounted to £5,910. 10s. 9d., and the expenditure (including £400 carried to the depreciation fund account) to £3,337. 0s. 9d.—giving a gross profit upon the actual working of the Company of £2,573. 10s. After adding thereto the reserve of £295. 13s. 8d. from last year's profits, and providing for all mortgage and debenture interest, a balance of £1,540. 11s. 4d. remains. Out of this the directors propose to set apart a sum of £300 to form the nucleus of a reserve fund for meeting any contingency which may arise, and it may also be applied in part from time to time to the reduction of the debenture issue. This will leave £1,240. 11s. 4d. out of which to pay the dividend, and the directors propose that a dividend at the rate of £7. 10s. per cent. per annum, free of income tax, absorbing £798. 15s., be declared upon the share capital of the Company. The balance of £441. 16s. 4d. will be carried to next year's net revenue account. The depreciation fund account now stands at £1,825. Since the last annual meeting the Company's circuits have been extended to Upperton and they now run through the following roads: The Avenue, Carew-road, Hartfield-road, Enys-road, St. Anne's-road, Arundel-road, Mill Gap, Selwyn-road, Upperton-road, Moat Croft-road, High-street, and the Goffs. The first lighting of the Upperton district took place on October 10 last. The light has been installed at St. Mary's parish church and at several private houses at Upperton, and a large addition to the roll of customers is hoped for during the coming spring. The capital for the Upperton extension was provided by the issue of debentures, all of which were privately subscribed. The Company's machinery, circuits, and mains are in excellent condition. Mr. James Arthur Skinner retires from the direction this year, but, being eligible, offers himself for re election. The auditors, Messrs. Hart Bros., Tibbetts, and Co., also retire, but may be re-elected.

Dr. REVENUE ACCOUNT.

To Generation of Electricity.	£ s. d.	£ s. d.
Coal and other fuel	849 13 7	
Oil, waste, water, etc.	102 9 10	
Repairs and maintenance of buildings, machinery, etc.	162 16 9	
Proportion of salaries of superintendents and officers	94 12 4	
Wages at generating stations	554 18 0	
		1,764 10 6
To Distribution of Electricity.		
Proportion of salaries of superintendents and officers	91 13 4	
Wages to linesmen, fitters, and labourers	96 15 1	
Repairs and maintenance of mains	88 0 10	
		276 9 3
To Public Lamps.		
Attending and repairs		86 15 6
To Rent, Rates, etc.		
Rents	51 2 0	
Rates and taxes	114 12 11	
		165 14 11
To Management Expenses.		
Directors' remuneration to December, 1893	200 0 0	
Proportion of salaries of managing engineer and secretary and accountants	154 15 3	
Stationery and printing	47 12 4	
General establishment charges	127 3 11	
Auditors of the Company	20 1 0	
		549 12 6
Insurance	48 19 7	
Depreciation on plant, machinery, etc.	400 0 0	
Bad debts and allowances	44 18 6	
		493 18 1
Balance representing gross profit carried to net revenue account		2,573 10 0
		£5,910 10 9

Cr.	£ s. d.
Arc lighting	709 15 11
Incandescent lighting	4,612 18 4
	5,322 14 3
Rental of meters	204 12 3
Rents	127 12 1
Sale of carbons, ashes, etc.	7 0 1
Installation and service—receipts, £1,328. 5s. 2d.; less expenditure, £1,079. 13s. 1d.	248 12 1
	£5,910 10 9

Dr. NET REVENUE ACCOUNT.

	£ s. d.
Interest on debentures	1,261 13 0
Ditto on mortgages	66 19 4
	1,328 12 4
Balance available for dividend carried to balance-sheet	1,540 11 4
	£2,869 3 8

Cr.	£ s. d.
Balance from last account, £824. 3s. 8d.; less dividend paid April, 1894, at 5 per cent., £528. 10s.	295 13 8
Balance from revenue account	2,573 10 0
	£2,869 3 8

Dr. BALANCE-SHEET.

	£ s. d.
Sundry creditors on open accounts	2,552 10 7
Reserve account for depreciation in plant, machinery, etc.	1,825 0 0
Balance of net revenue account	1,540 11 4
	£5,918 1 11

Cr.	£ s. d.
Sundry debtors	2,574 18 3
Stores on hand—coal, £66. 3s. 2d.; oil, waste, etc., £6. 12s. 8d.; general, £394. 3s. 10d.	466 19 8
Cash in hands of manager	10 0 0
Telephone rent paid in advance, £7. 14s. 2d.; insurance, £14. 16s. 11d.; rates, £32s. 16s. 3d.	55 7 4
Balance of capital account brought down	2,810 16 8
	£5,918 1 11

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Norwich.—The Town Council require by April 2 tenders for the supply of two Galloway boilers and the installation of electric light fittings at the new baths.

Dublin.—Among the stores for which tenders are invited by the Dublin, Wicklow, and Wexford Railway Company, are cylinder oil, cotton waste, indiarubber, and varnishes.

Manchester.—The Lancashire and Yorkshire Railway Company require by the 30th April tenders for the supply of an oil-engine, engine packing, signal and telegraph fittings, signal, telegraph and electric light wires, wire, etc.

Stowmarket.—The Urban District Council require by April 15 tenders for lighting the streets of Stowmarket from August 15 next to May 15, 1896, and also for lighting the post office clock. Particulars may be had of Mr. S. Prentice, clerk.

Worcester.—The Corporation invite tenders by April 6 for wiring Victoria Institute. Copies of specification may be obtained from the architects, Messrs. Simpson and Milner-Allen, 10, New-inn, Strand, London, W.C, accompanied by a deposit of £1. 1s. Plans of the lighting system may be seen at their offices, and on the works. Tenders are to be delivered at the offices of the architects.

Leicester.—The Gas and Electric Lighting Committee of the Corporation require by April 6 tenders for the supply of about 6,000 yards of high and low pressure cables. Specification and form of tender may be obtained upon application to the engineer, Mr. Alfred Colson, M.I C.E., Gas and Electric Lighting Offices, Millstone-lane, Leicester. Tenders are to be addressed to Alderman Lennard, chairman, and endorsed "Tender for Cables."

Rangoon.—Tenders will be received by the president of the Rangoon Municipal Committee, not later than November 4, for the lighting of Rangoon by electricity. Tenders should be accompanied by detailed plans, specifications, and estimates, and must state the terms on which the installation proposed will be undertaken. All information regarding the existing system of lighting and the cost, etc., with plan of the town, can be obtained on application to Messrs. Ogilvy, Gillanders, and Co., Sun-court, 67, Cornhill, London, E.C., accompanied by a remittance of £1. 1s. Tenders are to be sent in sealed covers and endorsed "Tender for Electric Lighting, Rangoon." Mr. J. Short, Rangoon, is the secretary of the committee.

RESULTS OF TENDERS.

Stafford.—The tender of the Electric Construction Company for a switchboard has been accepted by the Town Council.

Southport.—The Town Council have accepted the following tenders for additions to engine and boiler house at the electricity works: Section 1, H. Connard, Southport, brickwork, etc., £564; Section 2, J. Blanchard and Sons, Southport, joinery, etc., £541; Section 3, E. Wood, Manchester, ironwork, £669.

BUSINESS NOTES.

New Hartley.—The New Hartley Colliery is now lighted by electricity.

Western and Brazilian Telegraph Company.—The receipts for the past week were £3,411.

Bangor.—The Gas Committee have again discussed the question of electric lighting, and a report thereon is to be made at the next meeting.

Sunderland.—The Finance Committee of the Corporation have passed accounts which included £1,200 for dynamos and electrical apparatus.

Great Northern Telegraph Company.—The ordinary general meeting will be held in Copenhagen on Saturday, April 20, at 3 p.m., at the Exchange.

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West Cowes.—A report on the proposed electric lighting of the town has been prepared by the surveyor.

Engineering Business for Disposal —Mr. Simpson, auctioneer, of New Cross-gate, S.E., has particulars of a small engineering business in London for disposal.

Limerick.—A report for presentation to the Corporation Gas Committee is being prepared by Prof. Kennedy. The Corporation already possess electric lighting powers.

Willans and Robinson.—The registers of transfers and members of Willans and Robinson, Limited, are closed, prior to the third ordinary general meeting, to the 10th prox.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 24th inst. amounted to £943, as compared with £797 in the corresponding week of last year.

King's Lynn.—Mr. Jermyn has given notice to the Town Council to move at the next meeting that they apply for powers to introduce an electric light installation in the borough.

Chiswick.—The Works Committee reported to the District Council last week that the surveyor had announced that the works at the electric light station were progressing satisfactorily.

Luton.—The clerk reported to the Town Council last week that the Board of Trade had granted the Luton Corporation electric lighting order, and that it would be put in the first confirming Bill.

Bray (Ireland).—The Town Commissioners have been authorised to acquire and work telephones subject to the insertion in their Bill of a clause for the protection of the Dublin, Wicklow, and Wexford Railway Company.

General Traction Company, Limited.—This Company has been registered, with a capital of £7 in £1 shares, to acquire contracts grants, concessions, etc , for the construction of rail and tram roads, telegraphs, telephones, etc.

St. Luke's E C.—The Vestry have received a communication from Mr. Baker, one of St. Luke's representatives at the London County Council, stating that that body had refused to sanction the plans of the electric lighting company in the City-road.

Norwich.—In reply to a question at a meeting of the Town Council in regard to the proposed sewerage scheme, Mr. A. E. Collins, the city engineer, stated that he was not prepared to say whether pumping by electricity was cheaper than the use of Shone's ejectors.

J. G. Bartlett and Co., Limited.—This Company has been registered, with a capital of £2 000 in £1 shares, to acquire the business of mechanical, electrical, hydraulic, and general engineer, as hitherto carried on by Messrs. J. G. Bartlett and Co., at Redcliff Wharf, Bristol.

Dover.—The Dover Electrical Supply Company are making progress with their works. The company have already made arrangements for the lighting of Dover Admiralty Pier, and negotiations are in progress with the military authorities for installing the light in all the barracks.

Ossett.—A conference of representatives of public bodies at Ossett and Horbury was held on Monday, at the Ossett Technical School, to consider the question of the gas supply. It was mentioned that the question of electric lighting would shortly be brought before the authorities of both townships.

City and South London Railway.—The receipts of the Company for the week ended March 24 were £893, against £792 for the corresponding week of 1894, or an increase of £101 The total receipts for the current period of the present half-year are £11,716, against £11,192 in the corresponding period of 1894, an increase of £524.

Eastern Telegraph Company.—The Company announce the payment on April 11 of interest of 3s. per share, being at the rate of 6 per cent. per annum, on the preference shares, for the quarter ending March 31; and the usual interim dividend of 2s. 6d. per share on the ordinary shares for the quarter ended December 31.

Appointment Vacant.—As will be seen by our advertisement columns, the Vestry of Saint Mary, Islington, invite applications for the temporary post of canvasser. The salary offered is £3 per week and commission. Applications are to be addressed to the electrical engineer, 50, Eden-grove, Holloway, N., not later than Wednesday, April 3.

St. Olave's, S.W.—The Works and Finance Committee reported to the Board of Works last week that the clerk and surveyor had met the solicitor of the County of London and Brush Provincial Electric Lighting Company, Limited, in conference before Sir T. W. B. Blomefield, of the Board of Trade, and had agreed to certain amendments to the St. Olave's provisional order. The Board approved of the order as amended.

McPhail and Simpsons' Steam Patents.—Under the title of McPhail and Simpsons' Dry-Steam Patents Company, Limited, a company has been formed, with a share capital of £416,000, for the purpose of acquiring the business, plant, stock, royalties, goodwill, and patents of Messrs. McPhail and Simpsons, of Wakefield. The patents are directed to the perfection of a method of producing dry and superheated steam at a controllable temperature.

Yarmouth.—An installation of the electric light has been put up in the drapery establishment of Messrs. Palmer Bros. The order for the work was entrusted to Messrs. Laurence, Scott, and Co., of Norwich, and Regent street, Yarmouth, who have carried it out under the management of their agent there, Mr. Reavell. The scheme of lighting the windows embraces the use in the whole installation of 61 16-c.p. lamps distributed in groups of three and four, and shaded with white porcelain shades.

Stafford.—The Town Council last week adopted a report of the Electric Lighting Committee recommending the acceptance of the tender of the Electric Construction Company for a switchboard, and of Messrs. C. and W. Walker for an overhead tank to contain 12,000 gallons at a cost of £117. The committee also presented the regulations and conditions as to wiring consumers' premises, and asked for leave to authorise the engineer to purchase the necessary fittings, so that the wiring of premises may be begun at once.

Heanor.—The electric light has recently been substituted for gas in the factory of Messrs. J. Fletcher and Sons, of Heanor and Nottingham. The dynamo is driven by the 30 h.p. engine which drives the lace machinery. The dynamo has a capacity of 200 lights. The offices, drafting-rooms, and engine-houses are lighted by lamps of 16 c p. and 32 c.p,, and the lace machines have two 32-c.p. lamps each. The installation has been carried out by Messrs. Thomas, Danks, and Co., Limited, of Thurland-street, Nottingham.

Direct Spanish Telegraph Company.—The report for the half-year ended December 31 states that, after providing for debenture interest and redemption of debentures, there is a balance to the credit of revenue of £4,077. After adding the usual sum of £2,500 to the reserve fund the balance of revenue amounts to £1,577. To this the directors propose to add £1,166 from interest on investments, and recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference, and a dividend at the rate of 4 per cent. per annum on the ordinary shares.

Newport (Mon.)—It is stated that the day-load plant of the Corporation has been tested, and found satisfactory. This plant consists of a semi-portable engine of 50-i.h.p., cylinders 9in. and 14in., 16in stroke, and running at 135 revolutions per minute. The output of the alternator is 12½ amperes at 2,000 volts. The provisional plant has been handed over to the Corporation. The foundations for the larger machinery are practically complete, and the engines it is expected will be ready in a month, whilst the street lamps may be expected to be ready in two months.

Epstein Accumulators —The Epstein Electric Accumulator Company, Limited, of 215, Gresham House, Old Broad-street, E.C., give warning that plates are being offered by other makers of accumulators which are essentially Epstein plates, and they therefore caution users against employing plates which are made by infringing patents owned by them. Opinions in support of the validity of the Epstein letters patent have been given by Sir Richard Webster, Q.C., M.P.; Sir Horace Davey, Q C. (Lord Davey); Mr. Fletcher Moulton, Q.C , M.P.; Mr. Aston, Q.C.; and Mr. R. W. Wallace.

Foyers.—One of the directors of the British Aluminium Company, Mr. E. Ristori, A.M.I.C.E., has been engaged in making enquiries as to the operations which the company propose to carry out in the valley of the Foyers. A public meeting has passed resolutions approving of the establishment of the new industry in the district. Mr. Peregrine Birch, C.E., London, engineer to the company, accompanied by Mr. Graham and assistant, has been engaged at Foyers in surveying the ground and preparing the necessary plans for the excavations and embankments, and for the erection of the proposed works.

Bankruptcy Proceedings.—A first meeting under the failure of Mr. G. F. Rogers took place before the Official Receiver on Monday. The debtor, a telegraph engineer and general merchant, of Great Winchester-street, furnished accounts showing liabilities £27,982 (£19,800 expected to rank), and assets £264. He has also acted as director of public companies, and attributes his failure to liability on accommodation bills, for which he received no consideration, to loss in trading and investments and depreciation in value of securities held by creditors. A trustee and committee of inspection were appointed to wind up the estate in bankruptcy.

Richmond (Surrey).—A Local Government Board enquiry has been held upon the application of the Town Council for sanction to borrow £900 for fire brigade purposes. The Town Council was represented by Mr. Senior, assisted by Mr. Urquhart (of Messrs. Urquhart and Small, the electrical engineers to the Council), Mr. Brierley (the borough surveyor), and Mr Penn Lewis (borough accountant). Mr. Senior explained that some part of the £900 now asked for was required to complete payment for work already done, which had cost more than was originally anticipated. The cables for the fire-calls were estimated at £970, but the contract price was £980 and the actual cost £995 The call-posts were estimated at £230, but were contracted for at £265, and they ultimately cost £297, owing to the fact that an alarm was fitted inside the Town Hall, in addition to a post in the vicinity.

Manchester.—An enquiry was held last week by Colonel A. G. Durnford, on behalf of the Local Government Board, to hear evidence on the proposal of the City Council to borrow £100,000 for electric lighting purposes, and lesser sums for other schemes. Alderman Gibson, chairman of the Gas Committee, said that the £150,000 sanctioned by the Local Government Board for electric lighting purposes in 1892-93 had been overspent by about £14,000. In calculating that a plant equal to the supply of 20,000 16-c p. lamps would be sufficient for three years they reckoned without their host They were at once overwhelmed with applicants, and their energies had been and still were taxed to the utmost In September, 1893, they had 82 customers consuming energy equal to 4,000 16-c.p. lamps, and in February last 706 customers with 32,528 lamps. On the 12th of the present month they had 41 more applicants waiting to be connected, which would make a total of 747 customers consuming energy equal to 34,528 16-c.p. lamps. But they had another inducement. In the year from March, 1894, to March, 1895, they would be able to show a profit

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after deducting interest and sinking fund of between £7,000 and £8,000. Mr. Alderman Lloyd Higginbottom, deputy chairman of the committee, explained in detail the way in which it was proposed to spend the £100,000. He stated that the committee had decided that in the forthcoming year the price per unit should be reduced from 8d to 6d.

Edinburgh.—A sub-committee of the Town Council on electric light had before them last week a report by Prof. Kennedy on the extension of the electric light system by running cables along Princes-street and out the bridges to Nicolson-street and Clerk-street, the Grange and Morningside, so as to join the present system at the Barclay Church The report also embraced the question of extending the light to the Royal and Regent terraces and George square. The probable cost is set down at about £4,000. So far the question is only under consideration, and the committee has made no recommendation. The Town Council sub-committee in charge of the electric lighting had under discussion on Tuesday, Councillor Douglas's motion to consider and report whether any steps should be taken to secure that any faults in gas-mains and service pipes shall be detected and removed without delay. It was agreed that the special attention of the Gas Commission be called to the large amount of leakage of gas which takes place, and the desirableness of examining old pipes and renewing them, so as to give more security now that electric lighting is introduced. The committee were of opinion that the subsoil of Edinburgh was very much saturated with gas which had escaped, and it was stated that everything that could be done with regard to making tight the mains and conduits for the electric light had been done. The date of turning on the electric light was changed from the 10th to the 11th April.

Electric Pumping Machinery—The Lothian Coal Company, Newbattle Collieries, Dalkeith, N.B., have given an order to Messrs. Ernest Scott and Mountain, Limited, of Newcastle-on-Tyne, for another large set of pumping machinery. About two years since the same firm placed a contract with this company for two sets of pumping machinery, each set to deliver 200 gallons per minute against a head of about 700ft., the plant consisting of two horizontal engines, each of 120 effective horse-power, with dynamos, motors, and three-throw ram pumps of their improved type. This plant has given such satisfaction, and has proved so economical in working, that the firm have now given the present order to Messrs. Scott and Mountain, so that the plant, when completed, will be capable of delivering 600 gallons per minute against a head of 700ft., but in case of emergency it could be considerably pressed. The company also have an order in hand for an extension of the electric pumping plant which they supplied to the Cambois Colliery, Northumberland, and are supplying a dynamo and electric motor with gearing complete for driving a pump which has hitherto been driven by wire ropes at Newton Colliery, Felton, Northumberland. The company are busy in their engineering department, having orders in hand for the pumping machinery for H.M.S. "Venus" and "Diana," and also for H.M.S "Mars," and have recently completed for their agents in India two sets of stern-wheel machinery, and are in receipt of a third order for compound stern-wheel engines and boiler.

Cardiff.—A meeting of the Public Works Committee of the County Council was held on Tuesday for the purpose of appointing a deputation to appear before the Board of Trade with reference to the proposed by-laws for the government of telephone, telegraph, and other wires. Notices of objections to the by-laws had been received from the telephone company, the Rhymney Railway Company, the Bute Docks Company, the Taff Vale Railway Company, and the Great Western Railway Company, who all protested against the height at which it was proposed all wires should be carried. The Corporation asked for a minimum height of 35ft. in crossing roads and 25ft. elsewhere. The model by-laws adopted by other towns made the height 30ft. over roads and 18ft. elsewhere. After some discussion, it was decided to ask for the heights of 35ft. and 25ft., and a deputation was appointed to wait on the Board of Trade. A meeting of the Free Library Committee was held on Tuesday. It was mentioned that some time ago Mr. Massey was asked his opinion of a scheme which had been proposed for the electric lighting of the library. A long letter was read from Mr. Massey, in which he recommended a system of shaded lamps laid on the tables, which he said was the more comfortable and convenient mode as opposed to the question of appearances. He estimated the cost of the work at £500. The committee did not appear to agree with this scheme, preferring instead that the light should be arranged so as to give a distributed light over the whole of the various rooms. Eventually the matter was referred to the Lighting Sub-Committee.

Monmouth.—As mentioned in our last issue, a special meeting of the Town Council was held last week to receive Mr. Lailey's amended plans and estimates in connection with the joint drainage and electric lighting scheme, and to petition the Local Government Board for powers to borrow £20,000 with which to proceed with the work. The Mayor (W. Honeyfield, Esq.) presided, and there were also present the town clerk (Mr. T. R. Oakley) and the borough surveyor and inspector of nuisances (Mr. P. E. Wanklyn). A letter was read from Mr. Lailey, the engineer for the drainage part of the joint scheme, intimating that his estimate had been brought down to £5,965. The Mayor observed that the position, to his mind, resolved itself thus: Messrs. Bramwell and Harris offered to do the whole work for £18,000, and if they put the whole work in their hands they would have to add £200 to the cost as the amount of fees to be paid Mr. Lailey. Messrs. Bramwell and Harris's estimate for lighting and other work amounted to £12,200, for carrying out the whole scheme £18,400. Mr. Lailey's amended estimate, less £120, was £5,845, and that, with his 5 per cent. fees, which amounted to £292, came to £6,137, or with Messrs. Bramwell and Harris's £12,000, £18,335. So that the expense of following either course was practically the same. Personally he should be quite content to see the scheme progressing on its old lines; still, if it was the wish of the Council to put the whole work in Messrs. Bramwell and Harris's hands he would not stand in the way of it Alderman Vizard said that the difference being so very trivial, he proposed that Mr. Lailey's amended plans of March 6, 1895, be accepted. Mr. Hall seconded, and the resolution was agreed to unanimously. It was then agreed to apply for permission to borrow £20,000 to carry out the work.

Acton.—The District Council last week considered the offer of Messrs. New and Mayne to buy the Council's electric lighting order for £500. A letter was read from that firm suggesting as the basis of an agreement that in all the by-roads of the district 16-c p. incandescent electric lamps should be substituted for the existing gas lamps at an annual cost to the Council of £2. 18s. 6d. per lamp, that in the main road about 30 arc lamps, similar in lighting capacity to those used at Ealing, should be fixed, and that for them the Council should pay what they were now paying for gas lighting. Messrs New and Mayne further suggested that the Council should permit them to use 32 c.p. incandescent lamps in the main road after midnight. Mr. Buxton and Mr. Everitt pointed out that it was understood that the cost of the 16-c.p. electric lamps would be the same as that of the present gas lamps, and that the gas lamps at the present time cost only £2. 13s. each per annum. Mr. Rome replied that when the agreement was first discussed the cost of the gas lamps was £2. 18s. 6d., and Messrs. New and Mayne had evidently based their calculations on that price. The Surveyor said the firm were of opinion that the price of gas was likely to go up, and he had no doubt they would be very pleased to substitute for £2. 18s. 6d. the actual cost of the gas lamps, whatever it might be, when the agreement was actually signed. The surveyor further stated that he had ascertained that if the Council adopted incandescent gas lighting about as much gas would be burned as heretofore; the incandescent burners would cost 11s. each. As to the up-keep of the burners, at Kensington the Incandescent Gas Company had undertaken the maintenance of them for 12s. each per annum, but as they refused to undertake the work at Acton presumably that price was lower than the actual cost. Mr. Buxton protested against the proposal to tie the hands of the Council to a particular firm and system for 42 years. Mr. Rome felt that it would be a very great mistake for the Council to let the present chance slip. He would oppose to the utmost of his power any proposal that the Council should undertake the work themselves. After further discussion, Mr. Rome moved, and Mr. Miller seconded, that the terms of Messrs. New and Mayne's letter be accepted, subject to their agreeing to the adoption of a sliding scale of prices if the Council decided on that prior to the signing of the agreement. The motion was carried by nine votes against four.

Brighton.—An enquiry was held last week by Colonel J. T. Marsh into the application of the Council for sanction to borrow £48,100 for purposes of electric lighting. The town clerk (Mr. F. J. Tillstone) and the deputy town clerk (Mr. Hugo Talbot) represented the Corporation, the borough engineer and surveyor (Mr. F. J. C. May), the electrical engineer (Mr. Arthur Wright), and the borough accountant (Mr. H. M. Stevens) being also present. The Town Clerk, in opening the application, said the proposed loan of £48,100 for electric lighting might be divided into two sums—one of £42,900 for electric lighting within the powers of the Electric Lighting Act, and one of £5,200 for street-lighting under the Public Health Act. Having regard to the rapid increase in the demand on their generating plant, and the fact that last winter the existing works were only just sufficient to supply the demand, the Council thought it necessary to extend not only their generating plant, but also their generating building. Plans and estimates had been prepared for an extension estimated to cost £13,449, and the Council proposed to lay down additional plant at an estimated cost of £29,451, these two sums making up the £42,900 for the borrowing of which sanction was asked. It had been necessary to carry out portions of the work included in this estimate without waiting for the formal sanction of the Board, but these were all permanent works for which the Board would ordinarily grant a loan. Mr. F. J. C. May (borough engineer and surveyor) gave further details of the proposed extension of the electricity generating station and of the Madeira-terrace. He estimated the cost of the extension of the electricity station at £12,400, the cost of culverts for the mains and strong-room at the office at £936, of a weighbridge and fixing £105, making a total of £13 441, or, with an allowance for contingencies, £13,449. Mr. Arthur Wright (electrical engineer to the Corporation) gave details of the proposed extension of plant. It was, he said, proposed to put down six boilers of 250 h.p. capacity, the cost of which was estimated at £3,600. An economiser would be put down at a cost of £600, and the boilers would be fed by electrically-driven pumps at an estimated cost of £500. The cost of pipework connecting the new boilers with the existing system was estimated at £1,800, and the sum of £133 had already been spent on the governing gears of the present engines. The condensers, with the connecting pipes and pumps, would cost £2,500. It was proposed to provide two new steam dynamos, to cost altogether £5,500, and a spare armature costing £350 had been already provided; £5,619 was required for mains, the sum having been already spent or incurred in providing mains for streets not contemplated when the last loan was applied for; £400 was the estimated cost of laying on services to new consumers; and £1,455 was the cost of connecting consumers in 1894 in excess of the last loan. The cost of connecting the circuits of the proposed 115 arc

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lamps for public lighting was estimated at £1,000, and £494 was for work already done, covering a great number of sundries. The sum of £1,900 was provided for contingencies in carrying out the new work. Of the £5,200 proposed to be spent on public street-lighting £1.300 was the estimated cost of the lamps, globes, and switches, £3,150 the estimated cost of supports and fixing, £570 for connections, and £160 for the connecting cable run in the lamp-posts.

PROVISIONAL PATENTS, 1895.

MARCH 18.

5665. **Improvements in electro-pneumatic and pneumatic movements for organs.** Vincent Willis, 6, Bream's-buildings, Chancery-lane, London.

MARCH 19.

5671. **Improved storage battery.** Charles Langstone, Ben Young, and Aimé van den Bogaerde, Perry Barr, Birmingham.

5693. **Improvements in and relating to electrical railways and tramways.** Fred Pentz Bergh and Charles Wakefield Tarbox, 70, Market-street, Manchester. (Complete specification.)

5699. **Improvements in electric arc lamps.** George Robert Mac Intire, 5, John Dalton-street, Manchester. (Complete specification.)

5700. **Improvements in electric arc lamps.** George Robert Mac Intire, 5, John Dalton-street, Manchester. (Complete specification.)

5701. **Improvements in electric arc lamps.** George Robert Mac Intire, 5, John Dalton-street, Manchester. (Complete specification.)

5722. **Improvements in electricity meters.** Hugo Hirst and James Thomas Baron, 73, St. Stephen's-road, Upton Park, London.

5742. **Apparatus for automatically limiting the speed of electric cars.** Louis S. Wright, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5747. **Improvements in dynamometers.** Benjamin Franklin Perkins, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MARCH 20.

5867. **Improvements in electrical signalling apparatus for use upon railways.** Henry James Price and Luiz de Moraes Gomes Ferreira, 4, South-street, Finsbury, London.

5868. **An improved secondary battery.** Henri Cardozo, 4, South-street, Finsbury, London.

5875. **Improvements in and relating to conduits for electrical conductors.** Francis Lauder Muirhead, 124, Chancery-lane, London.

5878. **Improvements in or connected with the distribution of electricity.** Charles Henry Wordingham, 5, Victoria-street, Westminster.

MARCH 21.

5892. **A device for the better regulation of electric currents.** John Henery Robottom and Frederic Charles Geary, Church Gresley, Burton-on-Trent.

5913. **Improvements in means for regulating the electric light in railway-coach compartments.** Robert Edwin Gill and William Hockly, 9, Broomsleigh-street, West Hampstead, London.

5927. **A means of transmitting electrical impulses from pencil marks on paper or like material, and of reducing the electrical resistance of paper.** Richard Joseph Crowley, 40, King's-bench, Queenstown.

5936. **A current collector for electrically-propelled railway or tramway vehicles.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

5939. **Improvements relating to automatic telegraphs.** Angus Fraser and the Eastern Telegraph Company, Limited, 124, Chancery-lane, London.

5964. **Improvements in the construction of galvanic battery elements or cells.** August Höller, 47, Lincoln's-inn-fields, London.

5965. **Improvements in or connected with electrolytic cells.** Edward Augustus Allen, 47, Lincoln's-inn fields, London.

MARCH 22.

5984. **Improvements in or relating to signalling and communicating by telephony, and in apparatus used therewith.** Harold James Bentley, 55, Market-street, Manchester

5998. **An improved cup-and-ball joint for electrically connecting and disconnecting electric light fittings** Robert Walter Braham, 60, Red Lion-street, Clerkenwell, London. (Complete specification.)

5999. **Improvements in the method of and in apparatus for electrically lighting miners' safety and other lamps.** John Peel, 8, Quality-court, Chancery-lane, London.

6000. **Improvements in the method of and in apparatus for electrically lighting miners' safety lamps.** John Peel, 8, Quality-court, Chancery-lane, London.

6004. **Improvements in telephones.** William Phillips Thompson, 6, Lord-street, Liverpool. (Emil Kirschke, Germany.)

6006. **Improvements in electric railways.** Peter Friedrich Cornelius Bernhard Pretzsch, 45, Southampton-buildings, Chancery-lane, London.

6007. **Controlling apparatus for electrically-propelled railway trains.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.) (Complete specification.)

6008. **Improvements in springs for electrical conductors.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.) (Complete specification.)

6010. **Improved form of magnetic clutch.** Bernard Mervyn Drake, John Marshall Gorham, and H. Capel L. Holden, 66, Victoria-street, Westminster.

MARCH 23.

6035. **Non-resisting electric conductors** John Alexander Rossiter, Tivoli Hall, Kingstown, Dublin.

6048. **Improvements in the manufacture of flexible sheets for electrical insulation.** Carl Bollé, 57, Barton-arcade, Manchester. (Charles W. Jefferson, United States.)

6075. **Improvements in electric switches.** William James Davy, 40, Chancery-lane, London.

6084. **Improvements in electrical railway signalling and apparatus therefor.** Jules Ernest Florea, Viktor Takács, and Emerich Rittinger, 31, High Holborn, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1893.

6565 **Dry voltaic cells, etc.** Siemens Bros. and Co., Limited and Obach. (Second edition.)

1894.

5001. **Electric fuses and switches.** Essinger and Harden.

7711 **Element-board for electro-therapeutic diagnosis.** Bishop.

8238. **Electro-medical apparatus.** Clerke.

8240. **Ceiling rose for electric lamps.** Ball and Winter.

8480. **Galvanic batteries.** Rushton.

17525. **Laying electric conductors.** Jeckell.

21323. **Welding electrically.** Thompson. (Coffin.)

23944. **Electric rail and tram vehicles.** Diatto.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5⅝
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2¼-2⅝
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2½
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5-5¼
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	14¾-15¼
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	130-123
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2⅞-3¼
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	102 107
Electric Construction, Limited	2	¼-⅜
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1¼-1⅝
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1¼-1½
Elmore's French Company	2	—
Elmore's Wire Company	2	1¼-1½
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	10-11
—— Preference	—	12
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅛-7⅜
—— Pref.	—	—
Liverpool Overhead Railway	10	8½-8⅝
—— Pref.	10	13½-14
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	½-¾
Metropolitan Electric Supply	10	10½-10⅝
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5¼ 5½
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7-7½
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5¾-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅞-8
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7⅛-8
Yorkshire House-to-House	5	5¼-5⅜

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NOTES.

Price List.—The Indestructible Ignition Tube Syndicate, Limited, of 100c, Queen Victoria-street, E.C., have sent us a copy of their price list of incandescent and arc lamps and dynamos.

Bell Telephone Company.—The directors of the Bell Telephone Company have issued their balance-sheet for the year showing net profits, after deducting all expenses, amounting to £279,865.

Birthday Celebration.—Electrical illumination has this week played a prominent part in various German cities on the occasion of the celebration of the eightieth anniversary of Prince Bismarck's birthday.

Lecture.—Lord Kelvin last week lectured before the members of the Philosophical Society of Glasgow in the natural philosophy classroom of the university on the electrification of air and the thermal conductivity of rocks.

A Good Dividend.—The directors of the Aktien-Gesellschaft Mix and Genest will propose at the annual meeting early next month the declaration of a dividend of 11 per cent. for 1894 as compared with 8 per cent. in the previous year.

Municipal Telephony.—The Lord Provost's Committee of Edinburgh Town Council have resolved to recommend the Council to apply to the Postmaster-General for a license to establish a system of telephonic communication within the city.

New French Cable.—A Bill has been introduced by MM. de Mahy and Brunet in the Chamber of Deputies with a view to the establishment of a submarine cable between Tamatave, la Réunion, and Mauritius. The proposal has been referred to the Budget Commission.

Institution of Civil Engineers.—This institution still continues to increase in numbers, although not at the same rate as in former years. The list corrected to 1st inst. shows that there are now on the books 6,737 members of all classes against 6,557 in the corresponding period of 1894.

Northern Society of Electrical Engineers.—A paper by Mr. M. Holroyd Smith, entitled "Some Methods of Gathering the Energy in Electric Railways and Tramways," will be read at a meeting of this society, to be held on Monday next, 8th inst., at the Palatine Hotel, Hunt's Bank, Manchester.

City and South London Railway. — The Bill extending for a period of three years the time for the completion of the City and South London Railway has passed through its committee stage without opposition before the Chairman of Ways and Means. In the House of Commons on Monday this Bill was considered and ordered for third reading.

Royal Institution.—Lord Rayleigh will deliver the Friday (this) evening discourse at the Royal Institution. His subject will be "Argon." There will be no evening meetings on April 12 and 19, but the discourses will be resumed on April 26, when Dr. John Hopkinson will deliver a lecture on "The Effects of Electric Currents in Iron on its Magnetisation."

Utilising the Rhone.—The Société Lyonnaise des Forces Motrices du Rhône, who intend to utilise on a large scale the water power of the Rhone in connection with electric light and power work, have now commenced the organisation of their staff. M. Desarces, formerly with the Continental Edison Company in Paris, has already joined the Lyons company.

Tramcar Accident.—A telegram from New York on Monday stated that at Hazelton, Pennsylvania, an electric tramcar was descending a steep grade when the driver lost control. The engine and carriage dashed to the bottom, left the rails, and were completely wrecked. Three passengers were killed, two others sustained injuries, and about a dozen others were seriously injured.

Electric Call System.—The electric call system which is being established in Brighton as a development of the work of the post office has met with a gratifying degree of recognition; and, having regard to the initial difficulties which have to be overcome in opening up connections with the various districts of the town, the undertaking, under the direction of the postmaster, Mr. A. Wilson Hetherington, is gradually, but steadily, making headway.

Mitchell's Newspaper Press Directory. — The utter uselessness of such a directory as this may be understood if we say that the editor has not yet found out that the *Electrical Engineer* has for going on eight years been published as a weekly. Nor has he found out that such papers as *Lightning* and *Electricity* exist in any shape. Such a directory as this is on a par with a technical directory which purports to give a list of technical papers, and quietly leaves out of that list the rival it fears the most. The latter is a characteristic trait of human nature.

Switch for Damp Rooms.—The difficulty experienced in maintaining the insulation of switches in damp rooms is claimed to be overcome by the insulating switch which has been introduced by Mr. Adolf Schuch, of Worms-on-the-Rhine. It is a lever switch arranged on an earthenware insulator, the contacts being inside the latter. In case of any part of the switch becoming oxidised, it can be easily removed and another substituted at slight expense. The switch is specially intended for use in breweries and places where the operation of fermentation is carried on, and for mining purposes.

Inventors' Protection Society.—We are glad to learn from the *Elektrotechnischer Anzeiger* that a society has been formed in Berlin, under the title of the Deutscher Erfinderverein, for the purpose of protecting inventors from being duped by unscrupulous exploiters. The society, which already numbers a hundred members, undertakes to promote and obtain patents only for those inventions which are new and come out satisfactorily after being tested. The society, which is intended for the mutual protection of business men and manufacturers, will publish an official organ, and if it can accomplish what it proposes to do it should prove of great utility.

The Pacific Cable Question.—At the annual meeting of the Amalgamated Chambers of Commerce, which was held in London last month, the chairman, Sir Albert K. Rollit, D.C.L., M.P., addressed the meeting in advocacy of the British Pacific cable, and on noticing the presence of the Postmaster-General at the meeting strongly commended this subject to his consideration. In reply, Mr. Arnold Morley, M.P. (the Postmaster-General), expressed his sympathy with such extensions of telegraphic communication, and, while acknowledging the way in which the great cable companies carry on their work, took occasion to comment on the dissatisfaction occasionally expressed by the commercial world with respect to rates.

Novel Burglar Alarm.—A French contemporary states that the Administration Communale of Brussels have just resorted to electricity for annoying the light-footed gentry who burgle houses. It appears that in the offices of the first division of police has been fixed an electrical alarm, to which inhabitants can have their houses electrically connected on payment of a small subscription. Thus,

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on a burglar making his entry into a dwelling protected in this manner, warning is given of the fact at the police station by the ringing of a bell and the dropping on the indicating board of a number corresponding to that of the subscriber. As a result, the police proceed to the premises indicated and arrest the burglars at once—if they have not already departed, which is very likely.

Electric Fusion of Metals.—A Swiss paper states that Mr. Nicolai Slavianoff, a Russian engineer, has devised a method of welding metals similar to that of Benardos, and which can be with advantage be substituted for the latter when repairs to pieces of metal are necessary. According to Mr. Lohmann, of the firm of Messrs. Pintsch, Berlin, the working of the system is as follows: The object to be dealt with is connected to one of the poles of the source of electricity, and the metal bar to be used in effecting the repairs is connected to the other pole. The two electrodes are approached so as to cause an arc to occur. The metal bar soon begins to melt, and the liquid metal is allowed to fall upon the parts to be repaired. The electrodes are, of course, gradually moved towards each other as the bar is fused, so as to obtain an uninterrupted arc.

Metric System of Weights and Measures.—The Select Committee of the House of Commons appointed to consider the advisability of adopting the metric system of weights and measures on Tuesday resumed the hearing of evidence. Captain H. R. Sankey, R.E., of Messrs. Willans and Robinson, said that the metric system of measurement had been adopted by his firm for the last two years. The reason of the change was the advantage of working interchangeably with manufacturing engineers on the Continent. His firm's trade was mainly British, but no objection had been made to metrical measurements by British customers. The workmen were agreed that the millimetre was much more easy to work to than the English measure, and it was much less liable to error. The inconvenience of the change to the metric system was only felt by the workmen for a few days.

Lighting at Southampton.—It will be seen from the accounts of the Southampton Electric Light and Power Company which are given in another column, that there is a slight increase in the works' costs of ·07 per unit, notwithstanding the increased output. This is partly due to the fact that the company have had to pay on an average 3s. per ton more for coal than in 1893, and also because they have had since February, 1894, to supply at any hour of the day or night from mains distinct from their lighting mains two electric cranes which require a 100-i.h.p. engine and dynamo to be specially reserved for them. The point is more clear when it is stated that on the lighting the company sold 550 units per i.h.p., and on the crane work only 88 per i.h.p. The increase in management is due to the fact that in 1893 the directors took no fees. During the year the company have added a Willans-Crompton set of 100 i.h.p. and a Babcock and Wilcox boiler capable of evaporating 5,000lb. of water per hour from and at 212deg. F.

Rope versus Belt Driving.—The committee of Génie Civil de la Société Industrielle du Nord de la France are endeavouring to complete their experiments commenced last year in regard to the relative merits of rope and belt driving. For this purpose, M. Dubreuil, the president of the committee, has addressed a series of questions to the French Society of Civil Engineers. The tests hitherto made by the committee were with a 200-h.p. engine actuating alternately by ropes and belt a generator having a total output for supplying 2,000 incandescent lamps. The questions upon which information is now desired to complete the experiments are as follow: (1) method of driving from the steam-engine, by ropes or belt; (2) power transmitted, number and diameter of ropes, or kind of belt and thickness and width thereof; (3) distance between the shafts, diameter of flywheel, and speed and diameter of the pulley driven; (4) date of laying down ropes or belt, and price, including putting up; (5) approximate annual cost of maintenance and duration of running; (6) nature of the industry carried on; (7) personal opinion on the choice of the installation; (8) nature, number, and cause of any accidents.

Municipalisation of Tramways.—It is stated that in case the London County Council decide to proceed with their Bill to place and run carriages on any tramway which has been or may be purchased, the companies intend to offer a vigorous opposition to the passing of the measure. The latter, in their petitions, point out that the Bill as framed would enable the Council to use not only existing tramways, but any tramway which may be constructed in the future, and they contend that to sanction such wide powers is contrary to all parliamentary precedent and to the Tramways Act of 1870. Moreover, the Standing Orders of Parliament expressly prohibit the granting of such powers. These orders, they say, were revised within the last few years, and only permit local authorities to work tramways under special circumstances and subject to special conditions. None of the special circumstances exist, they assert, in the case of London, and as large sums of money have been embarked in tramway undertakings, they submit that it would be unjust to the many persons who have invested their money that the prohibitions of the 1870 Act and the Standing Orders should now be over-ridden. On general grounds they submit it would be unfair to allow the Council to enter into competition with them out of the moneys raised by the rates.

Electric Lighting in India.—A special feature of the investiture durbar at Government House in Calcutta recently was the electric lighting. According to the *Indian Engineer*, the large durbar shamiana was lighted by incandescent lamps of various sizes. In the compound, six 2,000-c.p. arc lamps were erected on wrought-iron standards. These lamps were run in pairs working on the 110-volt circuit used on the incandescent lighting and were absolutely steady. They were of the Crompton-Pochin type. The generating plant consisted of a 12-h.p. portable engine fitted with two flywheels, to which were belted two Crompton dynamos. The contract was entrusted to Messrs. Kilburn and Co., Calcutta, the local agents of Messrs. Crompton and Co., of Messrs. Richard Hornsby and Sons and Henley's Telegraph Works Company. It is stated that the excessive moisture of the soil in which the cables which convey the current from the Calcutta station to the lamps from the station at Halliday-street are laid has caused them considerable injury, and their immediate renewal is deemed to be absolutely necessary. The Municipal Commissioners have in consequence invited tenders from specialists for both underground and overhead cables, the tenderers to state the number of years for which they guarantee the proper working of the cables.

Electric Power in Sawmills.—An interesting installation of the electrical transmission of power has been carried out at the works of MM. Dietrich and Co., of Lunéville. The problem to be solved, according to *L'Electricien* of March 23, was to operate by electric motors the machine tools in a sawmill 200 metres distant from the generating dynamo; a 5-h.p. pump on the banks of the Meurthe, some 700 metres from the source of power; and a 21-h.p. ventilator arranged near the generating station. The dynamo is of the Pieper type, giving 425 amperes at 125 volts when driven at 630 revolutions a minute. As

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the load on the generator was expected to greatly vary (from 150 to 425 amperes), a compound-wound dynamo has been put down so as to maintain a constant pressure at all loads. The current is taken to a main switchboard from which three circuits are led to the sawmill, pump, and ventilator respectively. A distributing board, to which each motor is separately connected, is arranged in the sawmill, which contains three motors of from 10 h.p. to 12 h.p. each which actuate saws. The ventilator, which supplies air under pressure to a number of forges, is driven direct by a 22-h.p. motor. The working of the electric pump is controlled from the generating station, close to which is situated a reservoir supplied by the pump. Originally when steam power was employed the annual cost of working, including coal, attendance, maintenance, and lubrication, amounted to £180, whereas now it is only £23.

History Repeats Itself.—Whether comparatively new or very old, history repeats itself. When the promoters of the Paddington - South Kensington - Victoria Railway desired to construct this line, they were debarred from doing so by reason of the objections raised against the use of powerful electric currents in the neighbourhood of the scientific institutions at South Kensington, it being feared that the exceedingly sensitive instruments therein used would be injuriously affected. A similar state of affairs has arisen in Berlin, or at all events in ancient Charlottenburg, which, together with Munich, may be likened unto South Kensington or the Board of Trade laboratory. For word has gone forth that the Berlin-Charlottenburg Tramway Company intend to substitute electric for horse traction. But the Physikalisch-Technische Reichsanstalt object to the introduction of electric traction on that line. Although the home of the Anstalt in the Marchstrasse is some 250 metres distant from the point where the proposed tramway circuits would be installed, yet the authorities of the institute consider that the delicate instruments used in the Anstalt for standardising purposes would be seriously affected by the working of the projected electric tramway. But the most remarkable thing is the fact that, notwithstanding the objections of the Reichsanstalt, the Technische Hochschule, which all Berliners and metropolitan seekers know so well, has not raised its voice against the scheme, although it is situated in the immediate neighbourhood of the route proposed to be followed by the tramway.

The Pennsylvania Railway and Electric Traction.—The Pennsylvania Railway intends to equip its Mount Holly branch, 12 miles in length, with electric cars on the overhead trolley system. It is now understood, the New York *Electrical Review* states, that this equipment will be in the nature of an experiment which will have an important bearing on a longer branch of the same railway. It is reported that the Pennsylvania Railway has closed a contract with the General Electric Company for three sets of experimental apparatus of different sizes and styles to be used on the Mount Holly branch. The experimental car equipment will consist of one set comprising four 25-h.p. motors, one set consisting of one 75-h.p. motor and one set consisting of two 74-h.p. motors, each set to be placed under 40ft. passenger coaches, rather lighter in construction than those generally used on steam roads, and which will eventually be developed into a standard electric passenger coach by the Pennsylvania Railway. The result of the experiments on the Mount Holly branch will determine whether or not the Camden and Atlantic branch of the Pennsylvania Railway will be similarly equipped. This branch is about 59 miles long, extending from Philadelphia to Atlantic City, and it is one of the oldest steam railways in America. Granted that the Mount Holly experiments are a success, it is proposed to similarly equip the Camden and Atlantic road with a centre-pole trolley construction. The purpose is to run trains on 10 minutes' headway on schedule time of two hours for the 59-mile trip. The fare for the round trip will be placed at 1dol., and it is believed that the road, when electrically equipped, will do a very large excursion business.

The Madagascar Cable.—Telegrams from Madagascar inform us that the cable between Mozambique and Majunga has been laid. From the continental Press we gather that this cable, which may be called a "war cable," was manufactured by a combination of two French firms. The price agreed on for the cable when laid is given as £84,000, whereas an English company offered to do this work for £50,000. Doubtless the French Government prefer to pay the higher price with a view to affording experience in the manufacturing and laying of submarine cables to the firms who have taken up that industry in France. Of course the amount in excess of a reasonable profit may be looked on as a subsidy to the contractors. The following is translated from *Le Temps* of Wednesday: "We were able to announce in the *Petit Temps* of last night that telegraphic communication with Madagascar is established, uniting Majunga with the station of Mozambique. This pleasing intelligence will be well received, not only by all those who think that it is in the national interest to withdraw our foreign communications from the control of English companies, but above all by the families of our brave soldiers, who will appreciate this link. This accomplishment will prove to all doubters that our manufacturers are quite equal to their foreign rivals. We may also, perhaps, add that probably this result would not have been so quickly attained if we had employed English contractors—an unfortunate habit which we have hitherto had. On a recent occasion Sir John Pender, the chairman of a submarine cable company, spoke with some scorn of French manufacturers, who were, according to him, incapable of bringing this enterprise to a successful issue. Facts, however, have just given him the flattest of contradictions (*le plus éclatant démenti*)."

Electric Towing on the Bourgogne Canal.—Some further particulars have been published by M. Gaillot, engineer of the Ponts et Chaussées, in the *Annales* of that Department, concerning the system of electric towing adopted on the Bourgogne canal. The motive power is furnished by turbines arranged at Pouilly on the side of the first sluice of the contributary to the Canal de Bourgogne and at Escommes, in the neighbourhood of the first sluice of the Saône. The turbines, which run at 100 revolutions a minute, drive a horizontal shaft, from which the dynamos are driven. The current is transmitted to a three-wire system, 8mm. in diameter, carried on posts and by means of cross wires. The current is collected by means of a trolley, the long pole (24ft.) of which is arranged on the towing boat. This length of the trolley pole has been necessitated by the oscillation of the boat. The motor carried on the towing boat is of the Gramme type, connected by belt to a pulley driving the gear which actuates the pulley operating upon the chain. The towing boat is 50ft. long, 10ft. 8in. in width, and the draught is 1ft. 6in. A battery of 250 accumulator cells has also been installed at Pouilly. The battery is placed in shunt with the line, and is operated simultaneously with the generators. The towing installation has cost 135,000f. (£5,400), but this is reduced to 120,000f. (£4,800) when the accumulators, the use of which is considered hardly justified, are left out of consideration. From September 1, 1893, to April 1 following 81,000 tons were transported in 897 hours at the price of 5,900f. (£236). During the same period of

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the previous year 78,600 tons were hauled in 917 hours at the price of 8,000f. (£320). It is concluded from this that 1,000 tons require with steam 11·65 hours and cost 102f., and with electricity 11·01 hours at an expenditure of 70f.

Flexible Couplings.—It appears that more consideration is now being given to the use of flexible couplings for connecting power shafts. Some time ago we referred to the use of Snyers clutches at the Worcester electricity works, this being followed by a description of the employment of the same form of clutch at a small central station in France for connecting together gas-driven alternators. Since then a discussion has arisen in a French contemporary as to the merits and demerits of flexible couplings, and now a German firm (Messrs. G. Luther, of Brunswick) have brought out a clutch which very much resembles that of Snyers. It is formed of two discs, one carrying steel brushes and the other steel combs, the former being caused to engage with the latter on coupling up. The dimensions and weights of the various couplings made by the firm are as follow:

H.P. at 100 revolutions.	Dimensions in millimetres.			Weight of coupling in kilogrammes.
	A.	B.	C.	
4	420	310	340	80
8	460	340	375	132
14	500	380	420	198
25	550	415	455	275
35	585	435	480	390
54	610	460	505	520
70	645	480	530	670
95	710	530	585	830
118	750	570	630	1,000
155	770	590	650	1,240
200	840	645	710	1,500
270	950	740	815	2,200
350	1,085	860	945	3,150
460	1,215	975	1,075	4,300

As in the case of the Snyers clutches, the coupling in question is particularly suitable for connecting a loose pulley driven by both a steam-engine and turbine, or by either.

Electric Traction at Leipsic.—The shareholders of the Leipsic Tramways Company met on Monday at 39, Lombard-street, E.C., to consider a proposal for the sale of the undertaking to a German company. The Chairman (Mr. W. B. Hawkins) explained that there was a strong idea among the authorities at Leipsic that the seat of the company should be at that place, and that in view of the desirability of working the system by electricity, he thought this company would find some serious difficulty in the future if it remained in English hands. He thought the offer which had been made them was a liberal one, and one which they should readily accept—namely, £450,000—which represented about £15 for their £10 shares. The amount was payable as to about £15,000 in cash, and the remainder in cash or bonds carrying 4 per cent., at the option of the purchasers. He concluded by moving a resolution approving the principle of the proposed transfer, explaining that meetings for the formal winding up of the company and appointment of a liquidator would have to be held hereafter, if the present resolutions were passed. Mr. A. G. Kendal seconded the motion, which was carried unanimously. In this connection a Leipsic paper states that the negotiations between the Gesellschaft für Elektrische Unternehmungen and the management of the Leipziger Pferdebahn Gesellschaft have now been brought to a close. Subject to the consent of the before-mentioned meeting, and to that of the Council of the town of Leipsic, the tramway passes by purchase into the possession of the Gesellschaft für Elektrische Unternehmungen for the introduction of electric traction. In accordance with the conditions laid down by the Town Council, the latter company will form an independent company to carry on the electric tramway, with its seat in Leipsic. The transfer of the undertaking will probably take place in January next. It will be evident that the only point yet to be decided is to gain the consent of the Leipsic Town Council, and that may be taken for granted.

Heat Imparted by the Electric Light.—A French contemporary, the *Moniteur Industriel*, states that Captain Exler, of the Austrian army, has found that a 16-c.p. incandescent lamp gives off a maximum temperature of 94deg. C., and a lamp of 25 c.p. 101deg. C. Two lamps placed in a wooden receptacle yielded a temperature of 215deg. C., decomposing explosives such as gunpowder, ecrasite, pyroxyline, etc., but without exploding them. The receptacle having been filled with water, the latter became in a state of ebullition at the end of 15 minutes. In case of the breakage of the lamps, the powder and pyroxyline do not ignite, but this is not the case if an explosive gaseous mixture is present. The captain points out that too many precautions cannot be taken, notwithstanding the use of electric lamps, which, whilst reducing the danger of an explosion, do not completely remove that danger. From the experiments made, it is held that the solution of the problem does not in any way lie in the employment of a double bulb with an intermediate closed space filled with air or water. The heating of the water would be avoided by the use of a reservoir having double communication with the external envelope, an arrangement by which would be established a continuous current, and which would allow of the cooling of the water. But in order that the latter may be sufficient, the volume of water necessary would render the arrangement heavy and cumbersome, and the method is consequently not practical. A rational solution for the lighting of places where gas or explosive materials are present seems to be, according to the captain, simply in arranging the incandescent lamp in a glass cylinder closed at both ends by means of metallic cloth; the current of air would freshen the bulb, and the slight heating of the air passing out would not be detrimental. In case of the breakage of the bulb, the combustion of the filament would produce at most only a small internal explosion, as in miners' lamps, incapable of transmitting fire outside.

Telephonic Communication with Lightships.—Prof. Lucien I. Blake, in a report recently submitted to the Government, describes the method employed by him to telephonically connect the Scotland lightship with the shore at Sandy Hook. Before the experiments at the Hook took place, Prof. Blake succeeded in establishing communication between a lightship and the shore at Wood's Holl, Mass., by a method in which the telephone cable is fastened to the anchor chain. This worked well until the lightship dragged her anchor during a gale and snapped the cable. The New York *Electrical Engineer* states that in the experiments at Sandy Hook, however, new conditions presented themselves and the Wood's Holl system would not answer, so another arrangement was adopted and found satisfactory. Instead of the telephone cable passing through the fluke of the lightship anchor, and communicating, as in the other case, through the anchor chain with the vessel, the cable is to run to a spot near the lightship's anchor, within the field of the ship's circular swinging with the wind and tide, and this field itself is electrified. Another and smaller cable is attached to the end of the first cable, and runs at right angles to it in both directions. From this new cable, again, other still

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smaller cables run parallel to the first. In this way the field through which the lightship moves in her movements around her anchor is thoroughly and equally electrified. The Light-house Board has proposed to connect two such stations much further apart, where the conditions of the bottom, currents, and approaches are different. The places mentioned for these experiments were the Assateague Lighthouse, Virginia, to the Winter Quarter Shoal Lightship, distant 11 miles, and from the Cape Fear Lighthouse, North Carolina, to the Frying-Pan Shoals Lightship, distant 18 miles. The most important recommendation in this respect, however, is to lay a cable from Sankaty Head Lighthouse, on the island of Nantucket, Massachusetts, to the Nantucket New South Shoal Lightship, 30 miles south. This lightship is the most distant from the coast of any in the service, and is in the track of all coasting vessels going outside of Nantucket from north to south, and of vessels going to and from Europe.

Utilisation of Water Power.—The differences in level of many watercourses have from time immemorial been employed for the production of motive power, but it is only in recent years that the idea of utilising high falls has been practically carried out. One of these cases, which is to be found at Chapareillan, in the Isère Department, is described by *L'Industrie Electrique* of March 25. The Chapareillan fall, which is being exploited by the Société Générale d'Electricité, of Lyons, is produced by the stream Le Cernon, which descends from the Granier mountain in the Chartreuse group. The water is collected in a reservoir at a height of 1,062 metres. From here the water is led by means of a conduit 3,200 metres in length to the works, which are situated near the village of Chapareillan, at an altitude of 450 metres. At its upper part, and for a distance of about 2,000 metres, this conduit has an internal diameter of 350mm. (14in.); in the lower part the diameter is reduced to 30cm. (12in.). The thickness in the former case is only 4mm.; as it approaches the works it reaches 12mm., and its lineal weight then exceeds 140 kilogrammes per metre. The conduit has been constructed to deliver, when the works are in full operation and at the times of greatest consumption, 200 litres of water per second. The power obtained will be 1,000 h.p. when calculating upon an efficiency at the turbines of 70 per cent. It is intended to utilise this 1,000 h.p. by means of seven turbines, each of 185 h.p. running at 360 revolutions a minute. One of the turbines will be kept as reserve. The first turbine erected has been made by MM. Brenier and Neyret, of Grenoble. Each turbine will be coupled to a self-exciting alternator of the Zipernowsky type made by the Creusot Works. Two of these alternators are already in position, and the others are in course of construction. At full load they will each produce 25 amperes at 5,400 volts. The current will then be transmitted within a radius of 18½ miles. It will then be stepped down to 120 volts for distribution to consumers. The inauguration of the Chapareillan works will take place next month as far as Challes-les-Eaux. The advantages of utilising high falls, our contemporary points out, are of two kinds. In the first place, the high-pressure turbines indirectly produce an absolutely fixed light without the necessity of using regulators. In the second, and on account of the small discharge necessary to obtain a considerable power, these falls allow of supplying a considerable number of lamps relatively to the constant power at one's disposal. In fact, statistics show that in electrical installations combined for the transmission of motive power during the day and the energising of lamps, the average of the daily consumption does not exceed eight hours. If, then, at the source of water supply a reservoir is constructed capable of containing two-thirds of the delivery of the stream during 24 hours, we shall be able to supply a number of lamps three times greater than the normal discharge of the same stream would permit. That is the reason, our contemporary concludes, for the construction of the Chapareillan reservoir, which has a capacity of 3,000 cubic metres.

The Heilmann Electric Locomotive.—In a paper recently contributed to the American Institute of Electrical Engineers, Mr. Ward Leonard says of this locomotive: "In France I examined what I considered the most important electrical engineering development of all that I saw. It was the Heilmann electric locomotive. Having been for some years past a firm believer in the merit of this machine, and having been in correspondence with Mr. Brown, Mr. Heilmann's electrical engineer, as to an invention of mine used in this locomotive for the first time on a large scale, I was especially interested in it, and my hearers will please discount as they may think necessary my description of the advantages of a locomotive using my system of control. The locomotive I saw was the first one built, and was not in service when I was there. It had run 2,200 miles commercially, however, and as a result of the performance of this first locomotive, which was 600 h.p., they are now building two locomotives of 1,500 h.p. each, which it is expected will go into commercial service about June next. This electric locomotive carries its own central station with it. It is really a complete central station on wheels, with its power used for propelling itself. The entire weight of the locomotive is 114 long tons—that is, about 15,500lb. per driving wheel, which is about the same as our standard practice in this country. With a tractive coefficient of ·2 this means a draw-bar pull of 50,000lb., and, assuming friction at 6lb. per ton, we find that 50,000lb. draw-bar pull would enable us to pull 1,900 tons on a 1 per cent. grade at a low speed, say 15 miles per hour, and would give us ample draw-bar pull for handling a 200-ton train at any speed thus far seriously discussed. Most engineers who have heard of the Heilmann locomotive have derisively dismissed it from their minds as a ridiculous monstrosity of a crazy Frenchman, but I have for some time believed, and am now convinced, that you will in the immediate future be bound to give this machine the most respectful consideration. Under the electrical arrangement on this locomotive, the electric energy is used in such a manner that its voltage is varied in proportion to the speed desired, and the amperes are in proportion to the torque required, so that the electrical energy produced is utilised in the most efficient manner possible. An electric locomotive of this kind would probably cost for the first few about 30,000dol., each being equipped with a 1,500-h.p. boiler of our best marine type, and one of our best automatic cut-off compound engines directly coupled to a modern multipolar generator. I believe that a locomotive of this type could be built which would be able to pull 50 per cent. more weight than any of the present steam locomotives, and it could pull the same weight at 50 per cent. higher speed. I think this type of electric locomotive is the stepping stone between the steam locomotive and the electric locomotive operated from a distant central station. To properly try the experiment of operating a high-speed locomotive of 1,500 h.p. from a central station would undoubtedly cost nearly a million dollars. To try it with a locomotive of the Heilmann type would cost not more than 50,000dol., and if it proved successful, it is not much of a step to replace the boiler and constant-speed steam-engine with the moving contact and constant-speed electric motor for driving the generator already tested and proved satisfactory."

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THE THEORY OF ALTERNATING CURRENTS.—II.

BY A.INST.E.E.

§ 5. **Calculation of Inductance.**—Having considered inductance as a physical phenomenon accompanying varying currents, we shall now treat it quantitatively, and from the nature of alternating currents, pulsating alternately in positive and negative directions at a rapid rate, it is evident that the back pressure of self-induction is an important factor in all calculations dealing with alternating currents. As already mentioned, the coefficient of self-induction is a constant quantity, depending on the size and geometrical form of a circuit, and since alternators, transformers, and other appliances forming part of such circuits contain one or more helices, we shall first show how to determine the magnitude of this constant for a simple electromagnet. From the explanation and definition given, it is obvious that the problem is simply to determine the number of linkages per second due to unit current. In the first place, we must know how to calculate the magnetic flux set up in the coil by unit current passing through it. Any good text-book proves the rule for determining the flux, so that we shall here only state it. The intensity, H, of a magnetic field at the centre and inside a hollow solenoid or helix, through which a current, C (absolute units), is passing, is given by the equation

$$H = \frac{4\pi C n}{l},$$

where n = number of turns of wire, l = length in centimetres, and H = number of lines of force per square centimetre passing through the coil. To get the total number of lines of induction through the coil we must multiply H by the area, A, of cross-section of the coil—that is, the magnetic flux is $H \times A = \frac{4\pi C n A}{l}$ C.G.S. units. For unit current passing the flux is, therefore, $4\pi n A/l$, and these link themselves with each of the n turns, therefore the coefficient of self-induction, L, of the coil is $\frac{4\pi n A}{l} \times n$, or $4\pi n^2 A/l$. As this is expressed in absolute units, we must divide by 10^9 to reduce it to henrys. If the radius, r, of cross-section of the coil is given instead of the area, the above expression becomes $L = \frac{4\pi n^2 (\pi r^2)}{l \times 10^9} = 4\pi^2 n^2 r^2/l \times 10^9$, since $A = \pi r^2$. So far no notice has been taken of the iron core. The above expressions refer only to hollow coils. The presence of iron materially increases the lines of induction, and so increases the value of L, and if we assume that the iron core is not magnetised beyond 5,000 or 6,000 lines per square centimetre, we shall be approximately correct in assuming that the value of L is increased μ times, where μ is the permeability of the iron for the current used. The induction through the coil is denoted by the letter B, so that $B = \mu H$; consequently, $L = \frac{\mu \cdot 4\pi n^2 A}{l \times 10^9} = 4\pi^2 n^2 r^2 \mu / l \times 10^9$ henrys.

Let us now consider a numerical example. Calculate the coefficient of self-induction of a solenoid of 500 turns of uniformly wound wire, the mean radius of the coil being 2·8cm., and the length of the solenoid 22cm.

Since $L = 4\pi^2 n^2 r^2/l \times 10^9$ henrys, we get by substitution

$$L = \frac{4 \times 22 \times 22 \times 500 \times 500 \times 2{\cdot}8 \times 2{\cdot}8}{7 \times 7 \times 22 \times 10^9}$$

$$= 0{\cdot}00352 \text{ henry.}$$

If the helix be completely filled with iron, the permeability of which is 800, $L = 0{\cdot}00352 \times 800 = 2{\cdot}816$ henrys. This may be taken as a fair average of the value of the inductance of a relay of 100 ohms resistance, and will give us an idea of the retarding effect of self-induction in signalling appliances.

§ 6. **Time Constant.**—The consequence of this inductance of the above electromagnet is to retard the growth of the current just at starting, so that a short interval of time, t, must elapse before the current becomes a maximum, and Helmholtz has proved that the strength of the current C_t after a time t has elapsed, is given by the following equation, known as "Helmholtz's Equation":

$$C_t = \frac{E}{R}\left(1 - \epsilon^{-\frac{R}{L}t}\right),$$

where $\epsilon = 2{\cdot}7183$, the base of the natural logarithms.

By writing the equation thus: $C_t = \frac{E}{R} - \frac{E}{R} \times \epsilon^{-\frac{R}{L}t}$, or $C_t = C - C \times \epsilon^{-\frac{R}{L}t}$, where C is the maximum current, it is obvious that C_t is less than C. A little consideration only is needed to show that if L is large compared with R, then $\epsilon^{-\frac{R}{L}t}$, which denotes the *retardation due to self-induction*—*i.e.*, the fraction of the maximum current not reached—has an appreciable effect on the time, t, which must elapse before the current becomes a maximum. On the other hand, if L is small compared with R, then the *retardation* is slight. These remarks indicate the influence of the quantity $\frac{L}{R}$, which we must consider fully; but before doing so we will give several values of C_t for different values of t, so that the student may get a clear insight into the meaning of Helmholtz's equation. The example taken is the electromagnet already considered, and if E is 10 volts, then, since R is 100 ohms and L = 2·816 henrys, the values of C_t for different values of t are as follows:

t in fractions of a second.	$1 - \epsilon^{-\frac{R}{L}t}$	C_t
0·01 or $\frac{1}{100}$ sec.	1 − ·7012 = 0·2988	0·02988
0·015	1 − ·5872 = 0·4128	0·04128
0·02	1 − ·4916 = 0·5084	0·05084
0·02816	1 − ·368 = 0·632	0·0632
0·03	1 − ·3448 = 0·6552	0·06552
0·05	1 − ·1698 = 0·8302	0·08302
0·075	1 − ·06975 = 0·93025	0·093025
0·08	1 − ·05976 = 0·94024	0·094024
0·1 or $\frac{1}{10}$ sec.	1 − ·0287 = 0·9713	0·09713

Now, if L were zero, the maximum steady current as given by Ohm's law, $C = \frac{E}{R}$, is $\frac{1}{10}$ or 0·1 ampere, and this value would be reached instantly, whereas, in consequence of the inductance of the circuit, we see from the above table that one-tenth of a second must elapse before 97 per cent. of its maximum value is reached. The rate of growth is shown very clearly in Fig. 2, in which O X is the time line, the fractions of a second being denoted by lengths, whilst the resulting values of C_t in the above table are given as ordinates, from which we get the curve O P Q R.

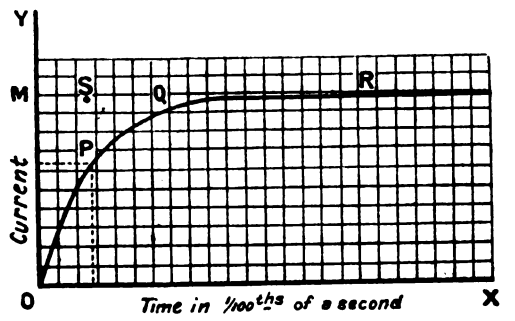

FIG. 2.

It will be noticed that the curve consists practically of three parts:

(1) O P, which is straight and nearly vertical;
(2) P Q, which is curved and forms the bend of the curve; and
(3) Q R, which is straight and practically horizontal.

The first part, O P, depicts the growth of the current during the time that energy is being spent in overcoming the back pressure, during which time the inductance, L predominates; this is gradually overcome, and then only the resistance, R, governs the rate of growth. Up to the point Q, the growth of the current depends upon the ratio of the inductance to the resistance—that is, upon the ratio L/R—which is termed the *time constant* of the circuit, and

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is so called because it is equal to the time taken by the current to rise to a definite fraction of its maximum value. In fact, if L be given in henrys and R in ohms, the fraction L/R is in seconds—that is, $L/R = t$ seconds.

To determine what this definite fraction is, we have only to substitute, L/R for t in Helmholtz's equation, and find the value of C_t.

$$\text{Now } C_t = \frac{E}{R}\left(1 - \epsilon^{-\frac{R}{L}t}\right) = \frac{E}{R}\left(1 - \epsilon^{-\frac{R}{L}\times\frac{L}{R}}\right)$$

$$= \frac{E}{R}\left(1 - \epsilon^{-1}\right) = \frac{E}{R}\left(1 - \frac{1}{\epsilon}\right) = \frac{E}{R}\left(\frac{\epsilon - 1}{\epsilon}\right) = C \times \frac{\epsilon - 1}{\epsilon}.$$

The fraction is therefore $\frac{\epsilon - 1}{\epsilon}$, but $\epsilon = 2{\cdot}7183$, and substituting this value, $\frac{\epsilon - 1}{\epsilon} = \frac{2{\cdot}7183 - 1}{2{\cdot}7183} = 0{\cdot}632$.

Therefore $C_t = 0{\cdot}632$ C.

In the example considered above, and for which the curve is plotted, it will be seen that this value is reached at the point P after 0·02816 of a second has elapsed. In this case 0·02816 is the time constant, since $0{\cdot}02816 = \frac{L}{R} = \frac{2{\cdot}816 \text{ henrys}}{100 \text{ ohms.}}$. It should also be noted that the deficit from maximum current at this point is denoted by the length P S, which is equal to $\frac{E}{R} \times \epsilon^{-\frac{R}{L}t}$ when $t =$ 0·02816 of a second. In Fig. 2, O M denotes $\frac{1}{10}$ ampere, or $\frac{E}{R}$.

ELECTRIC MAINS IN PARIS.*

BY A. MONMERQUE.

The work on the electric mains in Paris followed the concessions given by the Municipal Council in December, 1888, and was actually commenced in March, 1889. At this date the three following undertakers only started laying their mains—viz., La Compagnie Continentale Edison, La Société d'Eclairage et de Force par l'Electricité, and M. Victor Popp. Since then other companies have commenced work, as below—La Société du Secteur de Clichy in October, 1890, and La Société du Secteur des Champs-Elysées in June, 1892. The mains of La Société du Secteur de la Rive Gauche are still in course of construction.

Only underground systems of mains are allowed by the authorities in Paris, and so the question of type alone remains for consideration.

It will be useful to note the experiences gained in the last five years, and to review the principal faults found during that time. The conclusions which the facts point to are the following, which seem now to be well established in spite of adverse opinions held in the past by some engineers.

1. When the electric conductors are placed in metallic envelopes for mechanical protection, it is necessary to take great care to prevent any chance contact between the copper conductor and the envelope. To ensure this it is necessary to use insulated cables, and to take similar precautions as are required when armoured cables are employed and laid direct in the ground.

2. The conduits used, specially with bare conductors, ought to be waterproof, and as this condition cannot always be assured, a good system of drainage should be provided.

3. There is reason to specify the materials allowable in the construction of the conduits, and in this direction to forbid the use of glazed earthenware.

4. Where insulated conductors are employed the method of supporting them in the conduits should receive special attention, to avoid mechanical injury to the insulation, and consequently a low insulation resistance.

These very simple conclusions are extracted easily from the results which we give as briefly as possible below.

* *L'Eclairage Electrique.*

One section of Paris was supplied at first by insulated cables laid in cast-iron pipes, Fig. 1. The conductors were drawn in these pipes after they were laid. At once a large number of faults developed. The insulation of the conductors was insufficient, and also was damaged during the drawing-in process. The metallic pipes were the means of readily earthing the conductors, and it became impossible to continue the supply. The society quickly condemned this, its own system, but they did not abandon the metallic envelope.

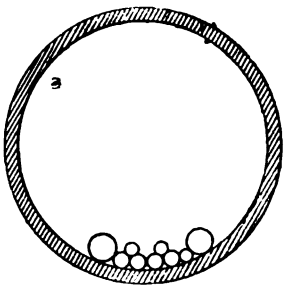

FIG. 1.—Insulated Main in Iron Pipe.

They employed a rectangular iron conduit, and endeavoured to ensure that no contact should ever be made between the copper and the iron conduit. To this end they had recourse to two different methods according to the pressure of the supply. For high-tension cables used to charge accumulators in series at 1,500 volts, they did not hesitate in adopting covered cables made to the following specification: a copper core insulated with one layer of pure rubber, two of vulcanised rubber, two of rubber tape, the whole covered with a lead sheath and a bituminous braiding. These cables were placed in chases of paraffined wood, as shown in Fig. 2. This system gives a double protection against contact between the copper and the iron conduit—*i.e.*, the insulation round the cable and the paraffined wood.

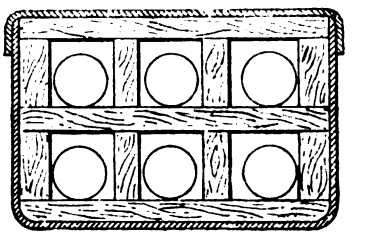

FIG. 2.—High-Tension Main in Paraffined-Wood Chases in Iron Conduit.

The conditions of the specification made the cable contractor responsible for the insulation resistance, and these mains have not given the trouble which has given rise to the faults which occurred with the first and third systems. Why, then, should this system not be generally used? It is cumbersome; again, it has the inconveniences of armoured cables, notably in the limitation in the density of the current without their safety. For 110-volt mains the above method was considered too costly, and it was decided to use bare conductors, and to prevent accidental contact with the iron conduit by paraffined blocks and porcelain insulators, shown in Fig. 3.

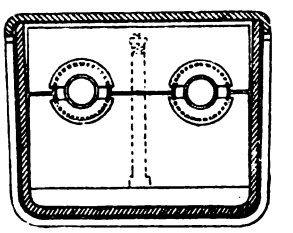

FIG. 3.—Bare Main in Iron Conduit. Section showing Insulating Supports.

To guard against the chance of an accidental contact at a point between two supports, the space round the conductors was filled up with an insulating mixture of pitch and limestone. These materials were ground fine and used in the proportions of from 40 to 50 per cent. of pitch to 50 to 60 per cent. of limestone. The mixture was made on the spot, and run in hot till it completely filled the metallic conduit.

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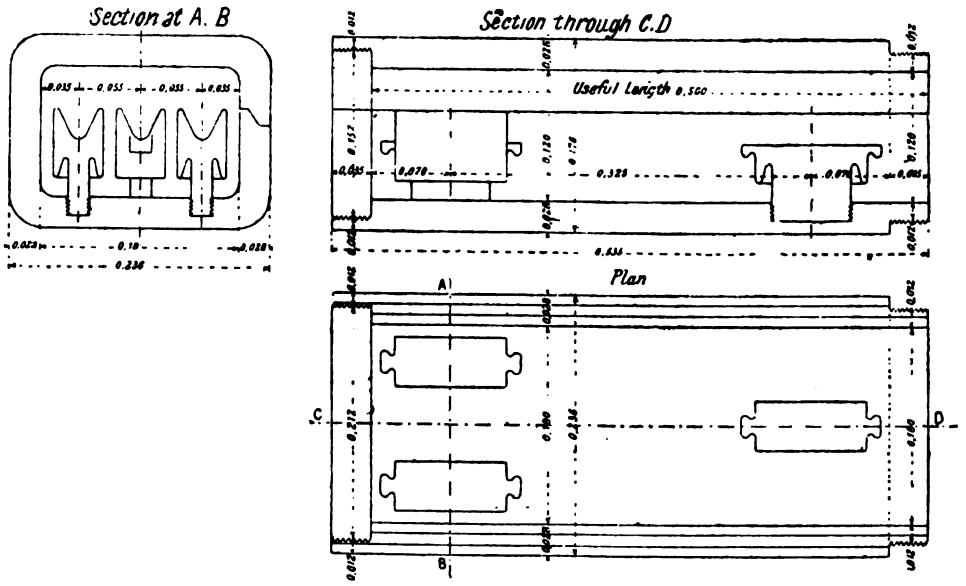
A short time after this system was started in regular use its defects resulted in bad accidents. Direct short-circuits were formed between the conductors and the conduit which are attributable to the following causes: The angles in the conduits were the seat of many faults, as at the bends the conductors did not keep their central position, but approached the iron sides, due to the displacement of the whole conduit from movements of the soil. The softening of the insulating packing whose melting point was too low also assisted this action. When the short-circuit once started, the pitch became completely liquefied and aggravated the fault.

As will be seen from the illustrations, the conductors are placed on porcelain insulators as when cement conduits are employed. In spite of these precautions, there have been serious faults. The company have, with a forethought and decision which is to be highly recommended, replaced all the pottery conduits regardless of the great expense caused by the change. They have used instead a cement concrete conduit of a smaller type, which can be adopted even in the most narrow streets. All their network now consists of the above conduits, and the results of careful work have resulted in the most satisfactory lighting of the section.



FIGS. 4, 5, AND 6.—Earthenware Conduit for Bare Mains.

The company, after this expensive experience, was obliged to acknowledge the faults of this system and to abandon these mains, which became an incessant source of danger under the public footpaths. The work of replacing them by armoured cables was carried out with method and rapidity by the new management of the company, who undertook the difficult task of remodelling and developing a very extensive network without stopping the lighting of the section. The execution of this very difficult work does honour to the engineers of the company, and the public safety was much benefited by these modifications in the system of mains.

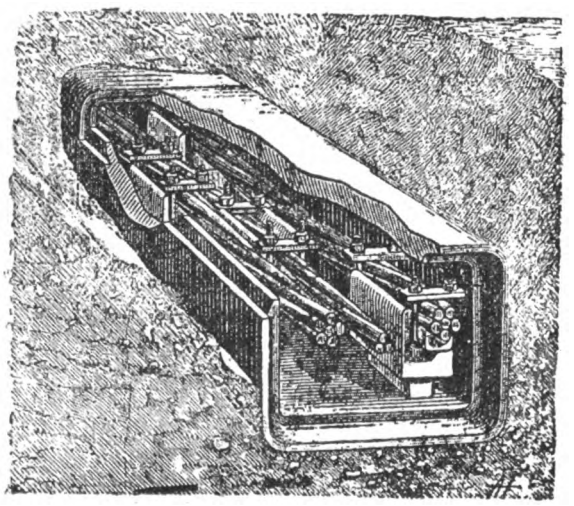


FIG. 7.—Earthenware Conduit.

One of the principal types of mains employed in Paris with bare conductors is the system of rectangular conduits made of concrete cement. One company, cramped by the use of this system in certain streets with narrow footpaths which had other mains under them, had recourse to the use of rectangular conduits of glazed earthenware, Figs. 4 to 7.

The phenomena which have been observed with earthenware conduits, and which have led to their being condemned, are very complex. Confining ourselves to the more important facts, after a certain length of time from the commencement of supply a quantity of whitish alkaline material was found in the conduits. The phenomenon continued, and, finally, the conduits were totally blocked by the material. On analysing the substance it was found to consist, not solely of alkaline carbonates, but also of pure sodium in sufficiently large fragments as to explode when thrown into water.

There are no means, as far as we know, of reproducing exactly the phenomenon in a laboratory, and many explanations have been given without it being possible to say which is correct. Some have attributed it to the sea salt used by the Parisian authorities for melting the snow. We doubt whether this method of clearing the snow is used at all on the footpath, but think it is reserved for roadways only, and even then the salt slush is swept away as soon as thawed and put down the sewers. A large quantity of Ourcq water is used in the operation, so that the quantity of salt on the footpath is soon diluted and quickly washed into the sewers. We cannot see, therefore, how this salt can penetrate under the footpath and get into the porcelain conduits. Others have blamed the cleaning of the shop fronts, but this explanation will not hold, as ordinary water is used for this purpose.

It is probable that the glaze of the earthenware, in the manufacture of which chloride of sodium is used, plays an important part in the production of this deposit. The conduits wherever they are laid are always humid, especially so in summer. The temperature of the air in them is below that of the outside air, and for this reason the moisture in the air condenses out the cold walls of the conduit. In winter, at any rate with bare cables the temperature of the air in the conduits is higher than that of the exterior air, and then the moisture does not condense as above.

It will be noticed that the joints in the conduit offer a comparatively easy access to water, and as we have stated, the subsoil of Paris is generally made ground, and hence is unstable and subject to frequent settlements. This leads one to conceive the possibility of water getting

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into the conduit, and to the ensuing consequences, such as the decomposition of the water into explosive gases.

Whatever may be the explanations of the various accidents to which the earthenware conduits have given rise, it is useless to urge their retention for future use, but rather the necessity of their interdiction.

CONTINUOUS-CURRENT DYNAMO WITH A SINGLE BEARING.*

The type of machine illustrated is stated to be one to which the best geometrical proportions have been given to the armature and field magnets. This dynamo, which has just been brought out by the Cail Company, has been designed by M. Helmer, chief of their electrical department. In the machine illustrated, which is of 2,500 watts capacity, Fig. 1 is a longitudinal section, taken through the axle, and Fig. 2 is an end elevation. In machines of this type the yoke is a mass of metal, merely serving to connect the two sides magnetically; as there is only a single bearing, the axle must necessarily overhang. The dimensions of the bed-plate have been kept as small as possible, so that the machine only consists of those parts which are absolutely indispensable. By this means there is a considerable economy in the weight of the machine, as well as in the cost of fitting the bearings. One very important point in the construction of these machines has been the difficulty of securing to the bearing ample and automatic lubrication, and reducing the mechanical friction. Mr. Helmer has surmounted this difficulty by using a special bearing, shown in detail by Fig. 3. The special feature of these bearings is the length of the brasses, which are seven or eight times as long as the diameter of the shaft.

The oil is contained in a reservoir, R, into which plunges a ring, *b*, carried by the axle. A number of curved wings are set round this ring, and form small troughs, giving a much larger supply of oil than would be the case with a plain ring. The brass, *d*, is held by a screw, which prevents it from turning or from having lateral play.

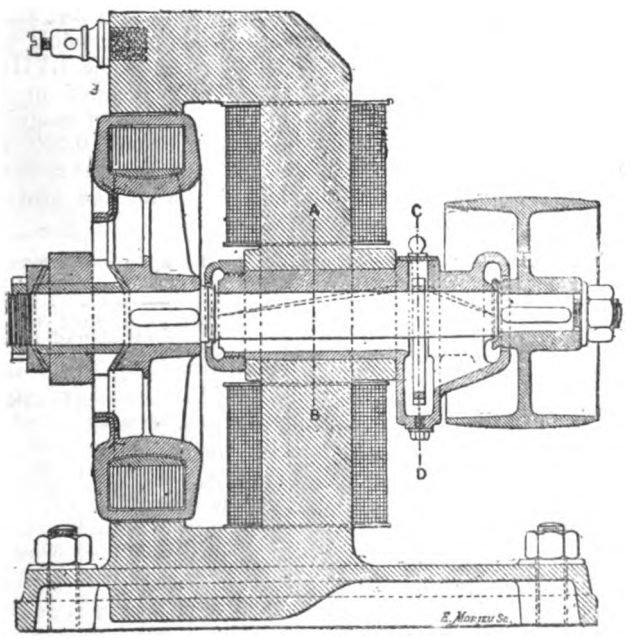

FIG. 1.

Lubricating channels are cut in it, and in the lower part is a larger channel, *r*, through which the oil that has been used is collected and returned to the reservoir, R; this channel runs the whole length of the bearing in a direction parallel with the axis of the shaft. It thus causes a solution of continuity in the frictional surfaces of the shaft and the bearing, which is very necessary for good lubrication. Thus, any dirt which may get into the lubricating channels will be carried along by the oil till it meets the drain *r*, by which it will pass into the reservoir R, where it will settle. With other systems of lubrication this dirt might stop at some point of the circumference, collect more, and thus cause friction.

Lateral play must be restricted as much as possible; otherwise the armature might partially pass out of the

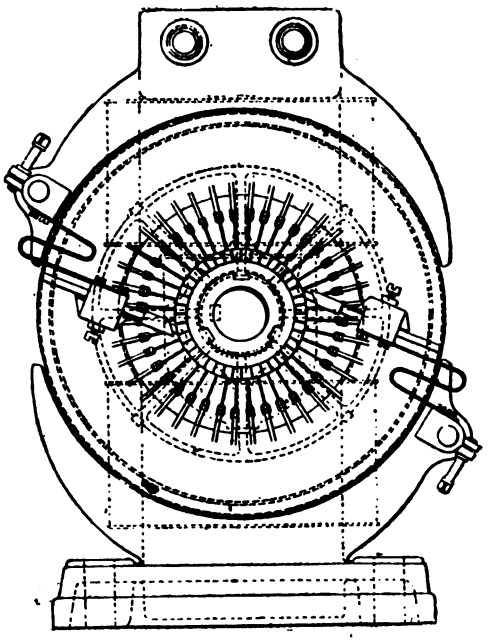

FIG. 2.

field. A maximum play of $\frac{1}{12}$in. to $\frac{1}{24}$in. has been adopted, limited on one side by a collar on the shaft, and on the other by a pulley. The oil is kept from being projected outwards, and more particularly from being thrown on to

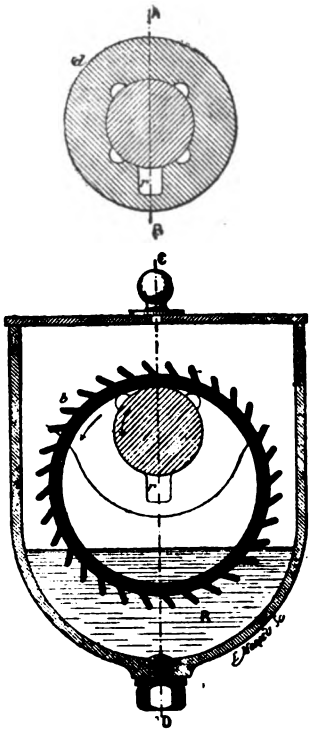

FIG. 3.

the field coils, by the use of two rings, which continually send the oil back towards the middle of the bearing. In small machines these rings may be replaced by collars of the same shape on the shaft and on the pulley.

The interpolar angles are very small; the pole-pieces are specially studied to ensure the most regular distribution of flow in the armature. In examining the design it will be seen that simplicity of construction has been combined with elegance of form. The space occupied by these dynamos being small, and the weight reduced as much as possible, renders them very suitable for motors, especially when driven direct with a coupling.

* Abstracted from the *Revue Industrielle*.

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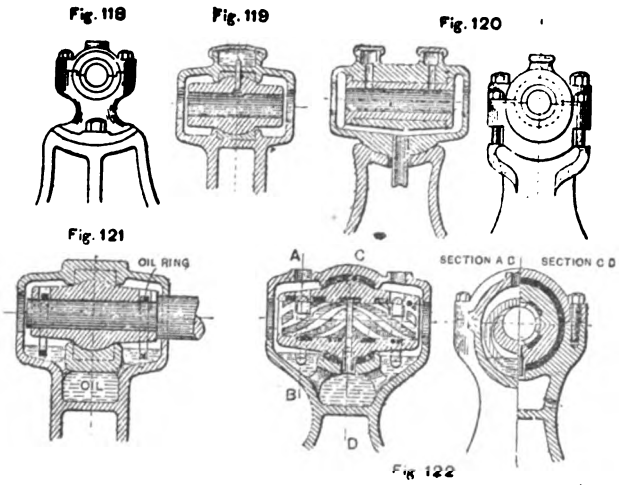
PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 374.)

(c) *Pedestals and Bearings.*—In the design of the base, especially when the portion of the field frame above the armature centre cannot be lifted off, care should be taken that the armature can easily be withdrawn longitudinally by removing one of the bearing pedestals, which, therefore, should be a separate casting. In machines where the lowest point of the armature periphery is in a considerable height above the base—as, for instance, in dynamos of the over-types,† Figs. 68, 71, 78, and 86 respectively, further, of the vertical double types, Figs. 77, 82, 87, 99, and 104 respectively, and of the radial and tangential outer-pole types, Figs. 88 and 90 respectively—it is preferable that the pedestal should be made of two parts, the upper part, which should have a depth from the shaft centre a little in excess of the radius of the finished armature, being removable, while the lower portion, which may be cast in one with the base, will form a convenient resting place for the armature in removal.

In most cases this problem of making high pedestals of two parts can practically be solved by boring out the pedestal seats together with the pole-pieces, thus providing a cylindrical seat for the pillow blocks, as shown in Fig. 118. This design is particularly advantageous also for machines in which the base forms one of the pole-pieces, as, for example, the forms shown in Figs. 73, 79, and 99, as in this case, outside of the finishing of the core seats, this boring to a uniform radius is the only tooling necessary for the base.



If the field frame is symmetrical with reference to the horizontal plane through the armature centre, the frame of the machine is usually made in halves, and the armature, in case of repair, can be removed by lifting it from its bed without disturbing the bearing pedestals. The bearing-boxes must for this purpose be made divided so that all parts of the machine above the shaft centre are removable. This design affords the further advantage that the bearing caps can be taken off at any time and the bearings inspected, and it has for this reason become a general practice in dynamo design to employ split bearings, even for types in which the armature cannot be lifted.

It is further of great importance that the bearings should not only be exactly concentric, but that they also should be accurately in line with each other; for large machines it is therefore advisable to effect automatic alignment by providing the bearings with spherical seats. This can be achieved either by giving the enlarged central portion of the shell a spherical shape, Fig. 119, or in providing the bottom part of the box with a spherical extension fitting into a spherical recess in the pedestal, Fig. 120.

In order to prevent heating of the bearings, the shells in modern dynamos are usually furnished with some automatic oiling device, the most common form of which, shown in Fig. 121, consists of a brass ring or chain dipping into the oil-chamber of the box and resting upon and turning with the shaft, thereby causing a continuous supply of oil at the top of the shaft. A further improvement of this self-oiling arrangement, patented in 1888 by the Edison General Electric Company, is illustrated in Fig. 122. In this the interior of the shell is provided with spiral grooves filled with soft metal, and forming channels for conveying oil from each end of the bearing to a circumferential groove which surrounds the shaft at the centre of the shell, and which communicates with the oil-chamber beneath the bearing. These grooves not only effect a steady supply, but a continuous circulation of oil, the latter being lifted from the reservoir into the shell by the oiling rings, thence forced by the spiral channels into the central groove, from where it flows backs into the oil-chamber.

46. *Joints in Field-Magnet Frame—(a) Joints in Frames of One Material.*—Magnet frames consisting of but one material may either be formed of one single piece or may be composed of several parts. If the frame is of cast iron or cast steel, in small dynamos usually the former is the case—*i.e.*, the whole frame is cast in one—while in large machines it generally consists of two castings; if, however, wrought iron is used, it is, as a rule, much more convenient to forge each part separately and to build up the frame by butt-jointing the parts. In so jointing a magnet frame it is of the utmost importance to accurately adjust and finish the surfaces to be united, so as to make the joint as perfect as possible, for every poorly-fitted joint, by reduction of the sectional area at that point, introduces a considerable reluctance in the magnetic circuit. If, however, the contact between the two surfaces is as good as planing and scraping can make it, a practically perfect joint is obtained, and the additional reluctance, which then only depends upon the degree of magnetisation, is entirely inappreciable for such high magnetic densities as are employed in modern dynamos. Experiments have shown that at low densities the additional magnetomotive force required to overcome the reluctance of a joint is very much greater comparatively than at high inductions, which is undoubtedly due to the pressure created by the magnetic attraction of the two surfaces across the joint, this pressure being proportional to the square of the density. The following Table LVIII. shows the influence of the density of magnetisation upon the effect of a well-fitted joint in a wrought-iron magnet frame, the induction in the iron ranging from 10,000 to 120,000 lines per square inch, and indicates that the reluctance of the joint becomes the less significant the nearer saturation of the iron is approached.

TABLE LVIII.—Influence of Magnetic Density upon the Effect of Joints in Wrought Iron.

Density of magnetisation. $\mathfrak{B}$ lines per square inch.	Pressure on joint due to magnetic attraction. $\frac{\mathfrak{B}^2}{72{,}134{,}000}$ lbs. per sq. in.	Magnetomotive force required for 1in.		Difference due to joint $\mathfrak{U} = \mathfrak{U}_2 - \mathfrak{U}_1$ ampere-turns.	Equivalent of joint	
		Solid $\mathfrak{U}_1$ amp-turns	Jointed. $\mathfrak{U}_2$ ampere-turns.		Air-space $\frac{\mathfrak{U}}{\cdot 3133 \times \mathfrak{B}}$ inch.	Length of iron $\frac{\mathfrak{U}}{\mathfrak{U}_1}$ inch.
10,000	1·4	1·7	6·7	5	·0016	3·0
20,000	5·5	3·2	12·6	9·4	·00155	2·9
30,000	12·5	5	19·1	14·1	·0015	2·8
40,000	22	7	25·2	18·2	·00145	2·6
50,000	35	9·5	31·4	21·9	·0014	2·3
60,000	50	12·7	38·1	25·4	·00135	2·0
70,000	68	18·3	45·7	27·4	·00125	1·5
80,000	89	27·6	55·2	27·6	·0011	1·0
90,000	112	50·8	76·2	25·4	·0009	0·5
95,000	125	68	91·8	23·8	·0008	·35
100,000	139	90	110	20	·00065	·22
105,000	153	134	150	16	·0005	·12
110,000	168	288	300	12	·00035	·04
112,500	176	391	400	9	·00025	·023
115,000	183	500	506	6	·00016	·012
117,500	192	600	603	3	·00008	·005
120,000	200	700	700	0	·00000	·000

At a magnetic density of $\mathfrak{B} = 10{,}000$ lines of force per square inch, each joint in the circuit is equivalent to an air-space of ·0016in., or has a reluctance equal to that of

* From the *Electrical World* (New York).

† In Chapter 41, page 249, the names "over-type" and "under-type" were accidentally exchanged, the former corresponding to the inverted and the latter to the upright single-horseshoe type.

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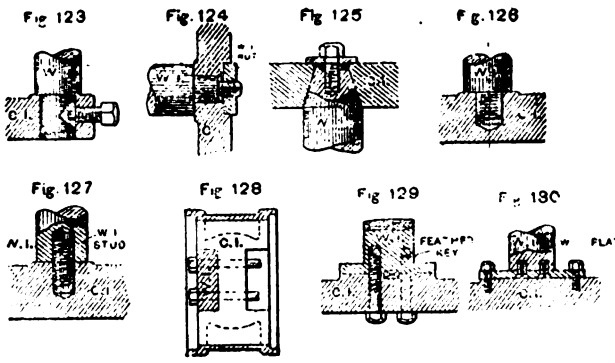
an additional length of 3in. of wrought iron; at $\mathfrak{B} = 100{,}000$ lines per square inch, the thickness of an equivalent air-space is only ·00065in., which corresponds to the reluctance of ·22in. of wrought iron at that density; and at or above $\mathfrak{B} = 120{,}000$, finally, a good joint is found to have no effect whatever upon the reluctance of the circuit.

(*b*) *Joints in Combination Frames.*—For magnet frames consisting of two or three different materials the same rule as for frames of one material holds good as to the nature of the joint, but since the ordinary butt jointing would limit the capacity of the joint to that of the inferior magnetic material, it is essential in the case of combination frames to increase the area of contact in the proportion of the relative permeabilities of the two materials joined. Thus, if wrought and cast iron are butt jointed, the capacity of the joint is reduced to that of the cast iron, whereby the advantage of the high permeability of the wrought iron is destroyed and the permeance of the circuit is considerably increased; and in order to have the full benefit of the wrought iron, the contact area of the joint must be increased proportional to the ratio of the permeability of the wrought iron to that of the cast iron at the particular density employed.

For a density in wrought iron of 100,000 lines of force per square inch, for example, a magnetomotive force of 90 ampere-turns is required per inch length of the circuit, and the same specific magnetomotive force is capable of setting up about 40,000 lines per square inch in cast iron; the contact area of a joint between wrought iron and cast iron in this case must therefore be increased in the ratio of 100,000 : 40,000, or must be made 2½ times the cross-section of the wrought iron, in order to reduce the permeability of the joint to that of the wrought iron.

In practice this problem of providing a sufficiently large contact area between a wrought and a cast iron part of the magnetic circuit may be solved either by setting the



wrought iron into the cast iron, or by extending the surface of the wrought-iron part near the joint by means of flanges; or, finally, by inserting an intermediate wrought-iron plate into the joint. In Figs. 123, 124, 125, and 126 are shown four methods of increasing the area of the joint by means of projecting the wrought-iron core into the cast-iron yoke or pole-piece, differing only in the manner of securing a good contact between the parts, the first one employing a set screw, the second one a wrought-iron nut, and the third one using a conical fit with draw-screw for this purpose, while in the fourth one the threaded projection of the core itself forms the tightening screw. Fig. 127 illustrates a modification of the method shown in Fig. 126, a separate screw stud being used instead of the threaded extension of the wrought-iron core. In case of rectangular magnet cores the arrangement shown by plan in Fig. 128 effects an excellent joint; in this the cores are inserted into the base from the sides, thus offering three surfaces to form the contact area. The manner of supplying the necessary joint surface by flanged extensions of the wrought-iron core is illustrated in Fig. 129, which shows the method of fastening employed in large multipolar machines, feather keys being used to secure exact relative position of the cores. In Fig. 130, finally, a joint is shown in which a wrought-iron contact-plate is inserted between the wrought-iron core and the cast-iron yoke or pole-piece with the object of increasing the area of the joint and of spreading the lines of force gradually from the smaller area of the wrought iron to the larger of the cast iron.

47. *Permeability of Various Kinds of Iron—Absolute and Practical Limits of Magnetisation.*—The field magnet of a dynamo has the function of supplying to the interpolar space in which the armature conductors revolve magnetic lines of force in a number sufficient either to cause the generation of the required E.M.F., in case of a generator, or to produce a motion of the desired power, in case of a motor. The cross-sections of the various parts of the field-magnet frame—that is, of the iron structure constituting the path or paths, for the flow of these magnetic lines—consequently must be dimensioned with reference of the number of lines of force to be carried, and to the magnetic conductivity of the material used.

The number of lines which by a certain exciting power or magnetomotive force can be passed through a portion of a magnetic circuit depends upon the area of the cross-section and on the magnetic conductivity of the material of that part of the circuit. The various magnetic materials, according to their hardness, have a different capability of conducting magnetic lines, the softest material being the best magnetic conductor. The specific magnetic conductance of air being taken as unity, the relative magnetic conductance or the relative permeance of the various magnetic materials is indicated by the ratio of the number of lines of force produced in unit cross-section of these materials to the number of lines set up by the same magnetising force in unit cross-section of air. This ratio or coefficient of magnetic induction is called the magnetic conductivity, or the permeability of the material.

The number of lines per square centimetre of sectional area set up by a certain magnetising force in air is conventionally designated by $\mathfrak{H}$, that in iron by $\mathfrak{B}$, and the permeability by the symbol μ. Between these three quantities, therefore, exists the relation

$$\mu = \frac{\mathfrak{B}}{\mathfrak{H}}, \text{ or } \mathfrak{B} = \mu \times \mathfrak{H} \quad . \quad . \quad . \quad . \quad (136)$$

Since for air the permeability $\mu = 1$, the number of lines of force per square centimetre of air is numerically equal to the magnetising force in magnetic measure—*i.e.*, in current-turns. Permeability is therefore often also defined as the ratio of the magnetisation produced to the magnetising force producing it.

While the permeability of air and of all non-magnetic substances is a constant—for air it is 1, and for diamagnetic materials slightly less than 1, for all stages of magnetisation—that of magnetic materials varies with the degree of saturation; the more lines a certain cross-section of iron carries the less permeable is it for additional lines. At a certain limit, for every kind of iron, a very material increase in the magnetising force does not appreciably increase the magnetisation induced, and the iron is then saturated with lines of force. This limit of magnetisation in annealed wrought iron is reached at a density of about $\mathfrak{B} = 20{,}200$ lines per square centimetre, or 130,000 lines per square inch; in soft steel at $\mathfrak{B} = 19{,}800$ lines per square centimetre, or 127,500 lines per square inch; in mitis iron at $\mathfrak{B} = 19{,}000$ lines per square centimetre, or 122,500 lines per square inch; in cast iron, with a 6·5 per cent. admixture of aluminium, at $\mathfrak{B} = 13{,}500$ lines per square centimetre, or 87,500 lines per square inch; and in ordinary cast iron at $\mathfrak{B} = 12{,}000$ lines per square centimetre, or 77,500 lines per square inch of cross-section. The magnetisations, however, to which these materials are subjected in practical electromagnets are taken far below the actual limits of absolute saturation, since "saturation curves" indicating the variation of the induction, $\mathfrak{B}$, with increasing magnetising force, $\mathfrak{H}$, show that from a certain point—the "knee" of the curve—the magnetisation increases much slower than the magnetising force which causes it. In wrought iron, for instance, an induction of $\mathfrak{B} = 13{,}580$ requires a magnetising force of $\mathfrak{H} = 25$, an induction of $\mathfrak{B} = 16{,}000$, a magnetomotive force of $\mathfrak{H} = 50$, and density of $\mathfrak{B} = 16{,}500$ necessitates an exciting power of $\mathfrak{H} = 100$; an increase of 100 per cent. in the magnetising force consequently causes a rise in density of 18½ per cent. at the lower magnetisation, while again doubling the magnetomotive

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force at the higher induction only causes an increase in magnetic density of about 3 per cent. In practice, therefore, the limits of the magnetic densities of the different materials are to be fixed with regard to the relative economy of iron and copper. Taking the practical limit of saturation too low means a small saving of copper at a large expense of iron, while too high a density effects a comparatively small saving of iron at a large expense of copper. Since copper costs many times more than iron, the densities should be limited rather low, the tendency toward the former extreme being preferable to that towards the latter. With this point in view, the "Practical Working Densities" given in the following Table LIX. are recommended for use in dynamo designing, while under the heading of "Practical Limits of Magnetisation" the highest densities are tabulated that the author would advise to allow in magnet frames of dynamo-electric machines. For sake of completeness the "Absolute Saturation" of the various materials, as given above, are added in Table LIX.

ABLE LIX.—Practical Working Densities and Limits of Magnetisation for Various Materials.

Material.	Practical working density.		Practical limit of magnetisation.		Absolute saturation.	
	Lines per sq. in. $\mathfrak{B}_m$.	Lines per sq. cm. $\mathfrak{B}$.	Lines per sq. in.	Lines per sq. cm.	Lines per sq. in.	Lines per sq. cm.
Wrought iron	90,000	14,000	105,000	16,300	130,000	20,200
Cast steel	85,000	13,200	100,000	15,500	127,500	19,800
Mitis iron	80,000	12,400	95,000	14,750	122,500	19,000
Cast iron, containing 6·5 % aluminium ...	45,000	7,000	55,000	8,500	87,500	13,500
Cast iron, ordinary...	40,000	6,200	50,000	7,750	77,500	12,000

48.—*Sectional Area of Magnet Frame.*—The magnet frame carries the total flux generated in the machine; according to Chapter 47, consequently, the cross-section of any portion of it must be

$$A_m = \frac{\Phi'}{\mathfrak{B}_m} = \frac{\lambda \times \phi}{\mathfrak{B}_m} \quad . \quad . \quad . \quad (137)$$

A_m = area of magnet frame, in square inches;
Φ = total flux generated in machine, from formula (109), Chapter 36;
ϕ = useful flux necessary to produce the required E.M.F. from formula (91), Chapter 32;
λ = factor of magnetic leakage, preliminary value from Table LII., Chapter 40; final value from formula (110), Chapter 37;
$\mathfrak{B}_m$ = magnetic density in magnet frame, from Table LIX., Chapter 47.

If only one material is used the value found from formula (137) is the uniform cross-section of the whole frame—*i.e.*, of the cores, the yoke, and the pole-pieces; in case of combination frames, however, the area for each material must be calculated separately:

For wrought iron, $$A_m = \frac{\lambda \times \phi}{90{,}000} \quad . \quad . \quad . \quad . \quad . \quad (138)$$

„ cast steel, $$A_m = \frac{\lambda \times \phi}{85{,}000} \quad . \quad . \quad . \quad . \quad . \quad (139)$$

„ mitis iron, $$A_m = \frac{\lambda \times \phi}{80{,}000} \quad . \quad . \quad . \quad . \quad . \quad (140)$$

„ cast iron containing 6·5 per cent. of aluminium,

$$A_m = \frac{\lambda \times \phi}{45{,}000} \quad . \quad . \quad . \quad . \quad . \quad (141)$$

„ ordinary cast iron, $$A_m = \frac{\lambda \times \phi}{40{,}000} \quad . \quad . \quad . \quad . \quad . \quad (142)$$

In combining the averages for the useful flux, taken from Table LI., Chapter 35, for the practical conductor velocities given in Tables VIII., IX., and X. respectively, with the leakage coefficients compiled in Table LII., Chapter 40, the average total flux, Φ, for dynamos of various kinds and sizes is obtained, and by then applying

TABLE LX.—Sectional Area of Field-Magnet Frame for High-Speed Drum Dynamos.

Capacity in kilowatts.	Conductor velocity (Table VIII.), feet per sec.	Average useful flux (Table LI.). Lines of force.	Average leakage coefficient (Table LII.).	Average total flux, Φ'. Lines of force.	Area of field-magnet frame.				
					Wrot. iron, $Am = \phi'$ 90,000 sq. in.	Cast steel, $Am = \phi'$ 85,000 sq. in.	Mitis iron, $Am = \phi'$ 80,000 sq. in.	Cast iron, 6·5% al $Am = \phi'$ 45,000 sq. in.	Cast iron, ordinary, $Am = \phi'$ 40,000 sq. in.
·1	25	200,000	2·00	400,000	4·5	4·7	5	9	10
·25	30	333 000	1·90	630,000	7	7·4	7·9	14	15·8
·5	32	550,000	1·80	990,000	11	11·7	12·4	22	24·8
1	34	880,000	1·75	1,640,000	17·1	18·1	19·3	34·2	38·6
2	36	1,530,000	1·70	2,600,000	28·9	30·6	32·5	57·8	65
3	40	1,875,000	1·65	3,100,000	34·5	36·5	38 8	69	77·6
5	45	2,550,000	1·60	4,080,000	45·5	48	51	91	102
10	50	4,000,000	1·55	6,200,000	69	73	77·5	138	155
15	50	5,700,000	1·50	8,550,000	95	101	107	190	214
20	50	7,200,000	1·45	10,400,000	115·5	122	130	231	260
25	50	8,500,000	1·40	11,900,000	132	140	149	264	298
30	50	9,900,000	1·40	13,850,000	154	163	173	308	346
50	50	15,500 000	1·35	20,900,000	232	246	261	464	522
75	50	22,000,000	1·35	29,700,000	330	350	371	660	742
100	50	28,000.000	1·30	36,400,000	405	430	455	810	910
150	50	39,500,000	1·30	51,400,000	572	605	643	1,144	1,286
200	50	50,000,000	1·25	62,500,000	695	735	782	1,390	1,564
300	50	70,000.000	1·20	84,000,000	933	990	1,050	1,866	2,100

TABLE LXI.—Sectional Area of Field-Magnet Frame for High-Speed Ring Dynamos.

Capacity in kilowatts.	Conductor velocity (Table IX.), feet per sec.	Average useful flux. (Table LI.) Lines of force.	Average leakage coefficient (Table LII.).	Average total flux Φ'. Lines of force.	Area of field-magnet frame.				
					Wrot. iron, $Am = \phi'$ 90,000 sq. in.	Cast steel, $Am = \phi'$ 85,000 sq. in.	Mitis iron, $Am = \phi'$ 80,000 sq. in.	Cast iron, 6·5% al $Am = \phi'$ 45,000 sq. in.	Cast iron, ordinary, $Am = \phi'$ 40,000 sq. in.
·1	50	100,000	1·80	180,000	2	2·1	2·2	4	4·5
·25	55	182,000	1·70	310,000	3·5	3·7	3·9	7	7·8
·5	60	292,000	1·60	467,000	5·2	5·5	5·8	10·4	11·6
1	65	462,000	1·55	715,000	8	8·4	8·9	16	17·8
2·5	70	930,000	1·50	1,400,000	15·5	16·5	17·5	31	35
5	75	1,500,000	1·45	2,180,000	24·2	25·6	27·3	48·4	54·5
10	80	2,500,000	1·40	3,500,000	39	41·2	43·8	78	87·5
25	80	5,320,000	1·35	7,200,000	80	85	90	160	180
50	85	9,120,000	1·30	11,900,000	132	140	149	264	298
75	85	13,000,000	1·25	16,250,000	180	191	203	360	406
100	85	16,500,000	1·22	20,100,000	224	236	251	448	502
200	88	28,400,000	1·20	34,000,000	378	400	425	756	850
300	90	39,000,000	1·18	46,000,000	512	542	575	1,024	1,150
400	92	47,800,000	1·18	56,500,000	628	665	707	1,256	1,415
600	95	62,000,000	1·17	72,500,000	806	855	905	1,612	1,810
800	95	74,200,000	1·17	87,000 000	967	1,025	1,085	1,935	2,170
1,000	95	84,200,000	1·16	97,700,000	1,085	1,150	1,240	2,170	2,480
1,500	100	97,500,000	1·16	113,000,000	1,255	1,330	1,410	2,510	2,820
2,000	100	110,000,000	1·15	126,500,000	1,400	1,490	1,580	2,800	3,160

TABLE LXII.—Sectional Area of Field-Magnet Frame for Slow-Speed Ring Dynamos.

Capacity in kilowatts.	Conductor velocity (Table X.), feet per sec.	Average useful flux (Table LI.). Lines of force.	Average leakage coefficient (Table LII.)	Average total flux Φ'. Lines of force.	Area of field-magnet frame.				
					Wrot. iron, $Am = \phi'$ 90,000 sq. in.	Cast steel, $Am = \phi'$ 85,000 sq. in.	Mitis iron, $Am = \phi'$ 80,000 sq. in.	Cast iron, 6·5% al $Am = \phi'$ 45,000 sq. in.	Cast iron, ordinary, $Am = \phi'$ 40,000 sq. in.
2·5	25	2,600,000	1·50	3,900,000	43·3	46	48·7	86·6	97·5
5	26	4,420,000	1·45	6,400,000	71·2	75·3	80	142·4	160
10	28	7,150,000	1·40	10,000,000	111	117·5	125	222	250
25	30	14,200,000	1·35	19,200,000	213·5	226	240	417	480
50	32	24,200,000	1 30	31,500,000	350	360	394	700	788
75	33	33,500,000	1·25	42,000,000	467	495	525	934	1,050
100	35	40,000,000	1 22	48,800,000	543	575	610	1,086	1,220
200	40	62,500,000	1 20	75,000,000	833	883	938	1,666	1,875
300	42	83,300,000	1·18	98 500,000	1,095	1,160	1,230	2 190	2,460
400	44	100,000,000	1·18	118,000,000	1,310	1,390	1,475	2 620	2,950
600	45	131,000 000	1 17	153,500,000	1.725	1,810	1,940	3,450	3,880
800	45	157,000,000	1 17	184,000,000	2 050	2 165	2,300	4,100	4,600
1,000	45	178.000,000	1·16	206,500,000	2,300	2,430	2,580	4,600	5,160
1,500	45	217,000,000	1·16	252 000,000	2,800	2,970	3,150	5,600	6,300
2,000	45	245,000,000	1·15	282,000,000	3,140	3,320	3,525	6,280	7,050

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formulæ (138) to (142) the sectional areas of the field frame for various kinds and sizes of machines can be found. In this manner the preceding Tables LX., LXI., and LXII., have been prepared, which give the cross-sections of field-magnet frames of different materials for high-speed drum machines, high-speed ring dynamos, and low-speed ring machines respectively.

The figures given for the areas directly apply to single-circuit bipolar dynamos only; for double-circuit bipolar and for multipolar machines they represent the total cross-section of all the magnetic circuits in parallel, or—for frames of only one material—the total area of all the cores of same free polarity the cross-sections of the various portions of the field-magnet frame are therefore obtained in dividing these figures by the number of magnetic circuits—*i.e.*, by the number of pairs of magnet poles.

For cases of practical design in which the fundamental conditions materially differ from those forming the base for the above tables, the areas obtained by formula (137) may also widely vary from the figures given, but by proper consideration these tables will answer even for such a case, and will be found useful for comparing the results of calculations.

(To be continued.)

WHAT, WHERE, AND WHEN.

Royal Institution, Albemarle-street.

April 5, 9 p.m.—Lord Rayleigh: "Argon."
April 6, 3 p.m.—Lord Rayleigh: "Waves and Vibrations" (sixth lecture).

Institution of Electrical Engineers, 28, Victoria-street, S.W.

April 5, 8 p.m.—Students' Meeting. C. V. Drysdale: "The Practical Measurement of Self-Induction."

Institution of Civil Engineers, 22, Great George-street, S.W.

April 5, 8 p.m.—Students' Meeting. H. Homes, Stud.Inst.C.E.: "The New South Pier, Sunderland."
April 9, 8 p.m.—Discussion on Mr. Thorneycroft's paper on "Torpedo-Boat Destroyers."

Society of Arts, John-street, Adelphi, W.C.

April 8, 8 p.m.—Cantor Lecture. D. Morris, C.M.G.: "Commercial Fibres."

Naval Architects, House of Society of Arts.

April 5, 12 noon.—1. T. Otto Schlich: "Vibrations in Steamers and Torsional Vibrations." 2. W. Mallack: "The Vibrations of Ships and Engines." 3. W. Hök: "The Transverse Stability of Floating Vessels containing Liquids, with reference to Ships Carrying Oil in Bulk."
April 5, 7 p.m.—W. A. Martin: "Induced Draught for Marine Boilers."

Junior Engineering Society, Westminster Palace Hotel.

April 5, 8 p.m.—W. G. McMillan: "The Study of Alloys."

INSTITUTION OF ELECTRICAL ENGINEERS, April 4.

Mr. R. E. B. Crompton (President) in the chair.

At last night's meeting of the Institution the following candidates were balloted for:

Member.—Alfred Henry Walton, 17, South-street, Manchester-square, W.

Associates.—Alfred Henry Avery, Stanley-road, Wallington, Surrey; Charles J. Bosanquet, 73, Queen Victoria-street, E.C.; Thomas William Broadbent, Victoria-lane, Huddersfield; Cadwallader Morgan Van Cuylenburg, the Public Works Department, Singapore; Richard McGillivray Dawkins, Stoke Gabriel, Totnes; Frederick Arthur Glover, 97, Queen Victoria-street, E.C.; John Peal Nelson, 148, Inverness-terrace, Hyde Park, W.; Louis Foley Noakes, 3, Kirkstall-road, Streatham Hill, S.W.; Stuart Richardson, care of Dr. Nelson-Jones, St. Helen's Villa, Swansea; William Walker, 36, Gillott-road, Edgbaston; Arthur Joseph Clarke Waterland, Chadwell Heath, Essex.

Students.—Norman Clough, Sutton Lodge, The Ridgeway, Enfield, Middlesex; Walter F. Daniell, Walpole House, St. Margarets; William Slater Nayler, 58, Lordship-park, Stoke Newington, N.; L. Nieuwenhuys, 39, Westmoreland-road, Bayswater, W.; Reginald Bycroft Roberts, 7, Broomfield-road, Chelmsford; Ernest Claud Short, 17, Northbrook-road, Lee, Kent; Alfred Milligan, Neville James Payn, and Ernest Noblett Ruddock, Faraday House, Charing Cross-road, W.C.

Mr. R. E. Crompton, before throwing open the resumed discussion of Mr. Langdon's paper on "The Employment of the Electric Light for Railway Purposes," announced that Sir David Salomons had presented a further sum (£500) to the Salomons Fund, which now amounted to £2,000. A cordial vote of thanks was passed to the donor.

Mr. W. Langdon, in supplementing his paper by some additional remarks, referred to the question of interest and depreciation mentioned at the previous meeting. He had always regarded depreciation as a bugbear in electric lighting. There was no possibility, he said, of the machinery being allowed to depreciate. The time might come when it would be necessary to replace existing machinery by that of an improved character, so that it might, perhaps, be advisable to make some allowance, which in his case had been put down at 5 per cent.

Mr. J. S. Raworth, who amused the meeting with some remarks on the delights of travelling on railways, congratulated the author on the excellent results obtained in regard to cost. The figures advanced by the author compared favourably with the works cost of central stations.

Mr. R. W. Weekes congratulated the Institution on the valuable paper under discussion. He considered that the last column in Table II. showed careful attention to the economical questions of fuel unless the cost of coal was abnormally low. On the other hand, why was the cost for labour about double that in an ordinary low-tension station? He regretted that the author did not give any information on the question of train-lighting from his large experience in the question in connection with the Midland Railway, and hoped that in the reply the subject would be referred to. The speaker then referred to the results obtained in America in lighting of trains by electricity, and gave the adjoining list extracted from Mr. W. Ward's paper before the American Society of Railway Telegraphists. He pointed out that from it the cost per candle-power hour was less with electric light than with either gas or oil, and that the Lewis system was almost identical with that used by Mr. Langdon.

System of lighting.	Initial cost per carriage.	Initial cost per 16-c.p. lamp.	Total c.p. per carriage.	Cost per day per carriage.	Cost per day per c.p. hour.
Direct from dynamo—	£ s. d.	£ s. d.		s. d.	d.
G. Gibb	67 12 0	3 15 0	288	3 11	·0162
Dynamo and accumulators—Pullman Co.	193 12 0	8 12 0	360	7 11½	·0264
Accumulators only—Pullman Company...	130 0 0	4 7 0	482	6 9½	·0210
Chesapeake and Ohio Railway	141 16 0	15 8 0	148	3 9½	·0246
Dynamo and accumulators—Lewis system	100 0 0	8 7 0	192	1 11	·0117
Pintsch gas.....	80 0 0	—	148	3 9½	·0306
Oil	14 8 0	—	148	2 6½	·0206

Mr. Leonard, the telegraphic superintendent of the South-Eastern Railway Company, referred to the arc light installation put up at the Bricklayers' Arms station as long ago as 1881. Recently, the South-Eastern Company made arrangements with the Charing Cross and Strand Company for the lighting of the arc lamps in the Charing Cross station at the rate of 5d. per unit, including carboning. A similar arrangement had been adopted in regard to the illumination of the Cannon-street Station by the City of London Electric Lighting Company.

Mr. Manville referred to the Portsmouth station, where the current furnished to the arc lamps had been increased from 10 to 12½ amperes, the result being a considerable benefit to the general lighting of the streets. It would be advisable in the future, he thought, to consider the question of increasing the ampereage above 10 amperes to, say, 12½ or 15 amperes. The rectifiers at Portsmouth had answered remarkably well.

Mr. Albright considered that it was a mistake to talk of a 10-ampere arc lamp giving 2,000 c.p. To do so was misleading, as a 10-ampere lamp did not give more than from 1,000 c.p. to 1,200 c.p. Concerning the best system to be adopted for the purpose under discussion, there was no doubt that the direct-current system, whether it was called three-wire or parallel system with middle-wire at 220 or 440 volts, was the best. As to the question of arc lamps, those of over 10 amperes were to be preferred, arranged, say, at a height of 50ft. to 60ft. from the ground. The system which he advocated fulfilled all the requirements suggested by the author in the direction of arc and incandescent lamps and motors from the same unit or units of generating plant.

Captain Sankey discussed the question of coal consumption and its connection with the load curves.

Mr. A. P. Trotter, said that the question was, what was the amount of illumination the railway companies obtained—not so many candle-power but the real lighting effect, or efficiency. The speaker then proceeded to discuss the lighting power of lamps placed at different heights and distances, of different ampereages and points of maximum and minimum illumination.

Mr. Alex. Siemens had something to say of the Albert Docks installation.

Mr. Chamen, who followed, amplified the remarks of the previous speaker in regard to the installation at the East and West India Docks. The system used was direct-current at 220 or 440 volts, and the method fulfilled every requirement. The system really covered an area of five miles, and the 15-ampere arc lamps were run eight in series.

Mr. A. H. Preece commenced to speak as our representative left the meeting after half-past nine. Before it terminated the assembly was expected to bring the discussion to a close.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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EARTHENWARE AS AN INSULATOR FOR STREET MAINS.

The recent gas explosion in the St. Pancras district, referred to in our issue of the 8th ultimo, has incidentally opened out for discussion a possible danger where bare electric light mains are supported on earthenware insulators. While examining the site of the explosion, Major Cardew found a whitish deposit on the insulators of the electric mains. This at first was stated to be caustic soda, but on further investigation it was found to contain pure sodium in sufficiently large quantities to cause violent ignition when water was poured on to it.

We regret that the Board of Trade advisers and our contemporaries should treat this matter as a newly-discovered fact, to be explained or doubted at will. Similar experiences at Paris have for some time been described in standard text-books, and the municipal administrations there have in the interest of public safety absolutely forbidden the use of the conduits in which the deposits occurred. Three of the leading electric lighting societies in Paris have at different parts of their systems used earthenware conduits for the use of low-pressure mains when laid under narrow footpaths. The departure from the usual cement concrete conduit was in order to economise space. The copper conductors were supported in these earthenware conduits on insulators, as shown in illustration to an article appearing in this issue. The whole conditions are therefore somewhat similar to those existing at St. Pancras, but are more favourable to the production of the white alkaline deposits. After a time a similar powder to that described by Major Cardew was found in these conduits, and the production continued till the whole space was choked up by the formation. In the alkaline material formed in this way there was a considerable amount of metallic sodium, and on being thrown into water the mixture ignited explosively.

The engineers of the companies boldly attacked the question before any municipal pressure was brought to bear on them, and have already replaced the earthenware conduits by concrete ones of suitable form. In spite of this evidence our esteemed contemporary doubts the formation of sodium under the condition existing in underground mains, and states that the damp state of the conduit would prevent sodium existing as such were it ever even present. We remember from elementary chemical lectures that Sir Humphrey Davy first obtained metallic sodium by electrolysing damp sodium hydrate, using a pressure from one hundred to two hundred volts. Major Cardew assures us that this hydrate was found at St. Pancras, and the rest of conditions appear to us to be exactly similar, even to voltage, to those used by Davy in these historical experiments. As to the formation of the sodium hydrate from the pottery glaze, we believe that such an action always occurs with commercial glaze when in a damp place. Although the combined silicates of the alkaline metals and calcium silicate form an infusible and insoluble glaze when mixed in the right proportions, we have it from the authority of H. Watts's "Dictionary of Chemistry," that

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"pure silicate of potassium or sodium, or a mixture of the two even with a sufficient quantity of silica to form a very infusible glass, would still be attacked by water or acid." The silicate of calcium reduces the solubility, but even "the moisture of the atmosphere produces a similar alteration and separates this sodium or potassium, leaving the silica and calcium silicate behind." The opalescent or iridescent film often found on old Roman glass and pottery ware is due to the film of silica left behind by this weathering action. Another chemical authority states that the glaze used on common pottery, although quite good enough for the purpose for which the article is required, is seldom insoluble.

We await with interest the result of the joint deliberations of the Board of Trade with the Royal Society and Institution of Electrical Engineers, and trust that they will not neglect the evidence on the same subject from other countries.

REVIEWS.

Electric Light Installations. In Three Vols. By SIR DAVID SALOMONS, Bart., M.A., etc. Vol. 1—The Management of Accumulators. Vol. 2—Apparatus. Vol. 3—Application. Seventh edition, revised and enlarged. Whittaker and Co., Paternoster-square.

Although somewhat late in the day to refer at length to these volumes, it is a task that pleases. We remember many years ago, unfortunately, a few of the bolder spirits among the scholastic profession inaugurating what proved to be an ephemeral change. The idea suggested, and for a short time carried out, was for an educational society to arrange for the criticism of an educational text-book at its meetings. A member previously appointed opened the discussion upon a particular chapter, and was followed by those present at the meeting who cared to speak, the chairman summing up more or less judicially at the end. It has often struck us that some such plan as this would be admirable education for the students of the Institution. Has the Council once more fallen into a rut; has it no initiation; or what is the matter? This book of Sir David Salomons would form a good text for discussion, and as the aim of the Institution is to obtain truth and promulgate the best practice, a little lively discussion among its younger members would perhaps open the eyes of some of the older men to the fact that ability and talent exist even outside the charmed circle. We suggest a change now and again from so-so papers to pure discussion upon matters of practice, or, if you must have academic discussions, upon matters of theory. Sir David Salomons in this book sets forth the results of practice. He very wisely shirks theories, and contents himself for the most part with describing things that have come under his own observation.

We must reiterate what we have once before said, that the industry at large has never realised its indebtedness to Sir David Salomons. At a time when electrical matters stank in the nostrils of men of the City—that is, of men who in the first place find money to carry out work—Sir David was experimenting upon a large scale at Broomhill and using his utmost endeavours to prove to wealthy men that electricity could be depended upon for lighting their houses. If the Lord of Burleigh should stroll around the country with his bride and once again exclaim

> "Let us see these handsome houses
> Where the wealthy nobles dwell,"

he would find that electricity played a prominent part in them, and we think that many of these installations are due to the initiative of Sir David Salomons. But it will be said this is not reviewing a book. Well, a seventh edition reviews itself. It says, I am wanted, and therefore I am here. Books that possess no individuality, no value, and no information are not sought after, while the very fact of a large sale points to a preponderance of good. The value of what Sir David Salomons writes lies in its practical character. The fittest has survived and is described. When he goes aside and touches theories he enters debateable ground, and is not so good. It may perhaps be well to ask how the heating effect is produced in a conductor if it is merely a directrix? Again, why should the directrix have a different influence upon alternate and direct currents? *Vide* page 195, vol. iii., where reference is made to Lord Kelvin and Prof. Hughes's researches. It is a good plan to follow the old advice, "Be not too hasty to adopt new theories." There is much in the ether theory to which scientific men have to close their eyes and minds and take without consideration, for examination leads them to quagmires deeper than the vaults of Dante's "Inferno." The first book describes the forms of accumulators mostly in use—such as E.P.S., D.P., Crompton-Howell, and Lithanode—the arrangement at Broomhill, and the precautions to be taken in charging, discharging, and testing. The second book discusses the apparatus other than batteries, from the engine to the lamp; while the third volume is a condensed account of the author's practical experience. We are glad to see him so strongly advocating the employment of consulting engineers, and contending that this leads to saving and not expense. His remarks on the precautions to be taken are good; and, indeed, the criticism of the whole work must be: it is good, and should be carefully read and studied.

THE COUPLING OF DYNAMOS FOR ARC LIGHTING.

BY W. H. LEA.

One of the objections to lighting by arc lamps in series is the necessity for the whole of the lamps in the circuit to be burning when two or three only may be required. This means both coal and carbons being burnt unnecessarily. The division of the current for incandescent lamps has been brought nearly to perfection, and a similar thing is required to make arc lighting popular. There is no doubt as to the suitability of the arc lamp for open places, large rooms, or railway platforms, where a good light is wanted.

Lighting by connecting two arc lamps in series on a 110-volt circuit is largely used where it would not pay to put down a separate circuit for the arc lamps, and is sometimes used on large installations. This is, in my opinion, a very unsatisfactory method, as there is the necessity of lighting two lamps where only one may be required, and, also, there is the waste of energy due to the resistance which is placed in circuit with every two lamps. It is acknowledged that the series system is the best for arc lighting, as there is always a reserve of E.M.F. in the circuit to compensate any overdrawing of the carbons or sticking of the mechanism of the lamps. Two of the most successful systems—the Brush and Thomson-Houston—are series systems.

We can, when running incandescent lamps in parallel, put dynamos on the line to take up any increase in the load. Why should we not put machines on in a series circuit, also in series, to give the increase of E.M.F.? Two or more machines can be coupled in series to give, if 1,000-volt machines, a pressure of 2,000 or 3,000 volts. All that is wanted is switching gear to put in or cut them out of circuit. The lamps would have to be controlled by short-circuit switches, and the circuit would have to be a simple series one; no parallel circuits could be allowed, as it would interfere with the switches—except, say, two five-ampere lamps were used on a 10-ampere circuit controlled by one switch.

For the sake of description I shall assume that three dynamos are used, each of 1,000 volts and 10 amperes; the switchboard to be fitted with the usual ammeters, a switch for each dynamo, and a switch for each dynamo field. This could be done by using three combination switches, as shown in the sketch.

In this sketch the left-hand machine is working at full pressure; all switches being open, the middle one has its armature in circuit only. It is immaterial whether the

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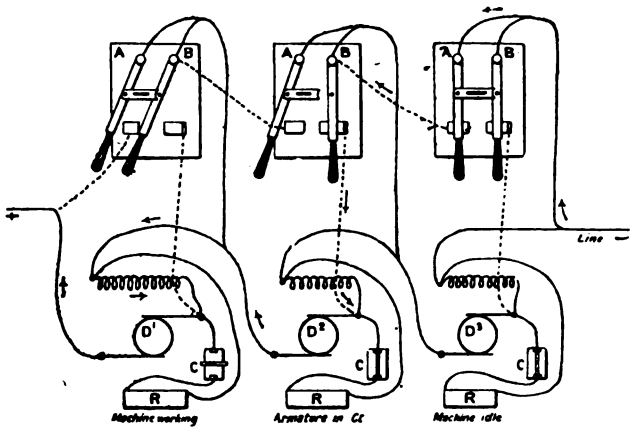
machine is running or not, as the armature is simply acting as a conductor. Owing to the fields being short-circuited by switch B, the right-hand machine is not working, as all switches are closed. There is also a resistance, R, across the field terminals, with a switch, C, which may be on the board or not, as most convenient.

We will assume that No. 1 dynamo is working with a full load; in this case the switches of the working machine will be open, and all the rest closed. Now more lamps are put on by opening their short-circuit switches, and we want another dynamo on. After starting and getting up to speed, open switch A, putting the armature in circuit; then, after seeing that the resistance, R, is all out, open the switch B, allowing the current to flow through the field winding—the greater part will pass through the shunt, R. We can, by altering this resistance, adjust the pressure to the required amount by shunting the field current more or less as required. If lamps are still being put on, another machine can be put on in the same manner. If lamps are being put off we first reduce the pressure by shunting part of the current from the field of the dynamo we wish to put off, and if the load is still further reduced the fields are short-circuited by switch B and the dynamo cut out by switch A.



It would be possible with ordinary switches to short-circuit a working machine, which, to say the least, would not improve the winding. To prevent this I propose a compound switch, by which, even if the armature switch were thrown over by a mistake of the attendant, the field switch would make contact first, and rob the field coils of their current. The switch C could be dispensed with, perhaps, by an additional segment to the field switch on the board. If this switch is used the resistance need not be made so large, as would have to be the case if we could not cut out the resistance.

It will be seen by the sketch that the switch B has a longer segment than A. If the switch A is thrown over by a mistake on the part of the man in charge, the switch B will be thrown over by a bar of insulating material between the two switch-bars. This bar is pivoted on switch A, but is only forked at B, and it is prevented from falling by a metal peg on the switch base on which it slides, the peg passing through a slot in the bar. This bar would be used in the case of a mistake. In the ordinary course the switch B would be put over first.

It would, perhaps, be desirable to have an engine whose speed could be varied to a considerable extent, as the slight alterations in the load could be met by altering the speed of the engine. With this arrangement it would be the duty of the dynamo-tender to keep the current constant in the same manner in which the E.M.F. is kept constant in incandescent lighting. It would be immaterial to him how many lamps were lighted, except he was required to note the power expended. In this case a high-tension voltmeter would be required.

An installation laid down on these lines could at any time be extended, it merely being necessary to cut the line at any point and insert one or any number of lamps and put another dynamo in the machine-room if required. This would, I think, be of great advantage for street or railway lighting, where an extension of the lamps might at any time be wanted, as it does not involve any alterations in the existing circuit beyond cutting the line and inserting the lamps.

In submitting this I do not know whether it has been tried before, or if there are any serious objections against it. I leave the type of dynamo and the ratio of the resistance, R, to that of the field coils to persons more qualified to decide these than myself. I am aware that shunting of the field-coil current is used as a means of regulating series electric motors, but I have not heard of it being used in the manner I now describe.

EFFECTIVE ELECTRIC LIGHTING.

BY W. PERREN MAYCOCK, M.I.E.E.

How few electrical fitters know what is meant by effective electric lighting; and of those who do know, how few take the trouble to apply their knowledge to their work. The result is that in ten out of a dozen electrical installations there is too much glare; by this I do not necessarily mean too much light, but too much light thrown in wrong directions. Unshaded lamps are placed so that they throw their light into the spectators' eyes and dazzle them. Especially is this noticeable in badly-lighted shop windows, showrooms, etc., where attention is attracted to details of objects, and the effect of the glare is more apparent than if a cursory glance only were taken.

Because of all this we are constantly hearing persons who, while admitting the superiority of the electric light in every other respect, wind up with the fallacious query, "But isn't it bad for the eyes?" Any intense light, especially sunlight, is bad for the eyes if it is allowed to shine directly upon their retinas. No sensible persons think of looking at the sun—they know what to expect, yet they will stare fixedly at an unshaded arc lamp, and on looking away to other things, and finding that they are dazzled, go away with the thought that there must be something very bad about the electric arc light, which, by the way, approaches more nearly in its character to sunlight than any other artificial light.

The effect of glare exists to a greater or less extent with any unshaded light—gas, oil, or electric. Take an ordinary table oil-lamp, for instance, and try reading a newspaper or book, first with the shade off, and then with it on. The irritating effect of the naked light, and its complete absence when the shade is on, especially if the shade is quite opaque, will be very noticeable.

The distinctness with which objects are seen does not depend so much upon the actual amount of light in a room, as upon the amount of light received by the eye by reflection from the objects themselves. Say one is looking at a picture, and a naked candle is held by the side of it, by far the greater portion of the light received by the eyes proceeds direct from the candle itself; the eyes are consequently dazzled, and the picture is but indistinctly seen. If, now, a shade, such as the hand, is held between the candle and the eyes, the light received by the latter proceeds from the surface of the picture, which is then seen to greatest advantage.

The pupil of the eye, which is the opening through which the rays of light are admitted to the retina, is constantly altering in size according to the amount of light thrown upon it. The less brightly an object is illuminated, the wider must the pupil dilate in order to render vision clear. When an object or objects are very brightly illuminated, the pupil contracts, to prevent an unnecessary amount of light from entering. The effect of light upon the pupil may be studied with a hand looking-glass and a candle. Stare fixedly at the candle flame for half a minute, this will have the effect of closing up the pupil until it is very small in diameter, as will be seen on looking at its reflection in the glass: it will then be observed to gradually dilate, owing to the less illuminated surface of the mirror. Now shut the eyes for two or three minutes, shading them from the light of the candle, and on opening them and looking at the glass the pupils will be found to be much dilated, and they will then gradually close up to suit the brighter light, especially if the candle be held near them.

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A person coming in from outdoors at night-time has no difficulty in seeing things, as the pupils of his eyes are already widely dilated in his effort to distinguish objects in comparative darkness. On the other hand, anyone going from a well-lighted room into a dimly-lighted one, or into the street, will not be able to distinguish objects until his pupils have gradually dilated to the necessary extent.

The glare or dazzling effect of unshaded lights will now be understood. When one enters a room where there are a number of unshaded incandescent lamps, the eyes instinctively turn towards them, and the bright rays from

FIG. 1.

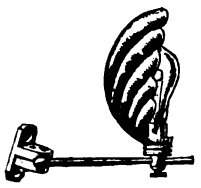

FIG. 2.

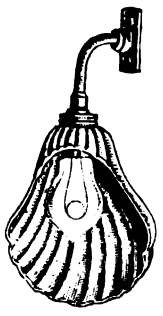

FIG. 3.

the filaments cause the pupils to contract: on looking away from the lamps to objects about the room which do not reflect such intense rays, even though they may be well illuminated, they are indistinctly seen until the pupils have had time to dilate to suit the vision to the less illuminated surfaces. Unshaded lamps have this effect even when they are not looked straight at, if their rays fall obliquely through the pupil upon the retina of the eye.

Electric lamps, both arc and incandescent, require shading much more than do gas or oil lights, as in the former we have a great amount of light proceeding from a very small area, and the rays are consequently much more intense. Compare the area of the filament of a 16-c.p. incandescent lamp with that of a gas-jet of the same power: the light of the latter being more diffused, does not exercise such a dazzling effect upon the eyes.

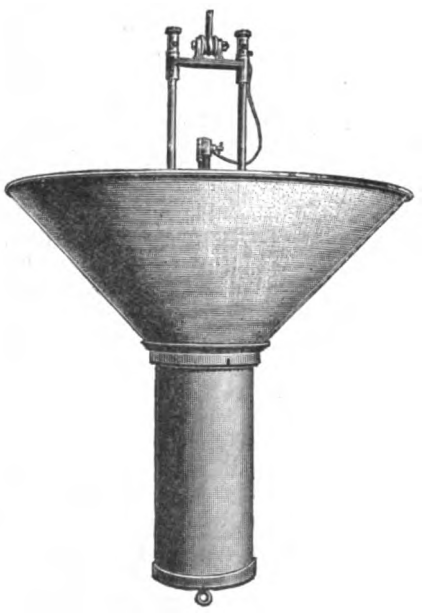

FIG. 4.

Whatever kind of light be used, the most perfect way of using it is to so arrange the lamps that no direct rays can reach the eye from the source itself; the light should be either wholly reflected from surrounding objects, or diffused, preferably the former. In the first case, neither the lamps or their globes can be seen; in the second, the lamps are surrounded by translucent globes, which diffuse or split up the rays from the arc or filament as they pass through.

The competition among electric light fitters, and the consequent cutting down of prices, is no doubt the cause of much of the bad work to be seen everywhere. Shades cost money, and so do intelligent fitters; but even when good prices are obtained the proper shading of the lights is often not seen to, in order to increase the profit: a very short-sighted policy, as almost anyone can appreciate the difference between a well and a badly lighted room, though they may not be able to give reasons. In many cases, where there is no stint either of money or material, the final result is deplorably bad, through simple ignorance on the part of the foreman, and often also of the superintending "engineer," of the proper distribution and arrangement of lights—a matter which, after all, is very simple, as we have shown above.

When shades are used the lights are often too much shaded, so that an unnecessary amount of light is cut off. It is only necessary to shade lamps on that part which could be seen by a person in the room. For instance, in the case of a wall bracket in a room where general illumination is required, the rays from the lamp in the direction of the wall, the ceiling, the floor, and across the room above the level of one's head, should be unimpeded. This could be best done by having a shade to each lamp of the shape shown in Fig. 1,* the shade being tapered off more or less at the top and bottom, according to the height at which the lamp was placed. These shades are made of nickel or silver-plated metal, or of porcelain or ground glass; and they are capable of being turned round on the lamp-holder so that their position may be adjusted. In conjunction with ornamental brackets they would not look so plain as when seen alone, as shown in the figure. They might be rendered more artistic by serrating the edges, and in the case of porcelain or ground-glass ones, by painting floral designs on the back on an opaque coloured ground. Figs. 2 and 3 illustrate forms of shell reflectors of nickel plate and ground glass respectively. The fittings there shown are intended for shop-window and showroom lighting, but the reflectors could of course be applied to any form of fitting. For the general illumination of a room, the shade in Fig. 2 cuts off too many rays at the top, while that shown in Fig. 3 cuts off too many at the bottom; but in any case they would prevent rays from striking the eye. Shades made of natural shell are very effective, the pearly white interior of the shell forming a very good reflector, while the shell itself, being slightly translucent, allows a soft and diffused light to pass through.

The most natural method of illumination, like daylight illumination, would be a general distribution of light all over the room in the manner above described; but in some cases, as in dining-rooms, studies, etc., many people prefer to have the majority of the light thrown on the table, the rest of the room being comparatively dark; but in these and in any other cases, whatever the distribution of the light, no direct rays from the filaments should be allowed to fall on the eyes.

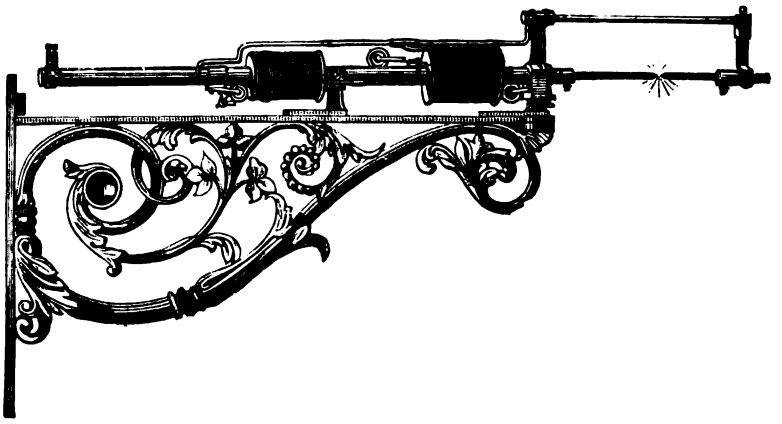

FIG. 5.

Some eyes are more sensitive than others to bright spots of light in a room, as from unshaded lamps; and with everybody these have a tendency to keep the pupils of the eyes in a partially contracted state, which unfits them for

* The electros for Figs. 1, 2, and 3 have been kindly lent by the General Electric Company, of 71, Queen Victoria-street, E.C.

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obtaining the best visual effect when turned to less illuminated objects. When a given number of lamps are shaded, according to the character and material of the shades, from 30 to 50 per cent. of the light may be cut off: and yet things are seen more distinctly than if the lamps were unshaded, for the reason that the rays of light reach the eyes from the most effective source—viz., from the surface of the objects in the room.

When arc lamps are used, owing to the much greater amount of light evolved for a given expenditure of current, a building or hall with a white ceiling of moderate height may be wholly lit by light reflected from the ceiling, the lamp being turned upside down, and the light thrown upwards by means of an enamelled iron shade. Such a lamp is shown in Fig. 4, and is made by Mr. A. W. Richardson, of Worsley-road, Patricroft, near Manchester. This method of *inverted arc lighting* has been introduced into many workshops, and is a great success. In addition to the advantages to the eyesight already mentioned, there is the consideration that no sharp shadows are thrown by this reflected light. In one case, a room 24ft. square and 12ft. high, with a whitewashed ceiling and lit by one of the Richardson inverted lamps placed in the centre, had a perfectly diffused light everywhere; the diffusion being so good that men sitting at benches with their backs to the lamp could carry out minute work with ease. Messrs. Lowcock, Hill, and Co., of Blackpool and Manchester, also manufacture such lamps at their Cornbrook Works. Improvements have recently been effected in the mechanism of the lamps made by this firm.

The advantages of such a light in workshops, leaving health considerations out of the question, will be appreciated by those who know what a workshop is like with numerous naked gas-jets alight. There are brilliant spots of light here and there on the benches and over the machines, but the jets have to be moved about to suit the work, and even then they illumine it unequally, and give false ideas of shape and size. In cotton and dye mills the inverted arc system of lighting has already made good headway. The murky atmosphere prevailing in manufacturing districts renders artificial light necessary for a good portion of the working hours: and when at first it was attempted to replace gas by ordinary arc lamps, the latter were found useless on account of the hard shadows cast; but since the inverted lamp has been introduced arc lighting has much increased.

Another lamp adapted for reflected lighting is shown in Fig. 5, and is made by Messrs. H. J. Joel and Co., of 31, Wilson-street, Finsbury, E.C. As will be seen, the lamp is placed horizontally on an ornamental iron wall bracket, and the light may either be thrown ceilingwards by means of a reflector, or the lamp may be placed above the ceiling and the light allowed to shine through an opal or frosted glass ceiling light or skylight, the effect being very soft and pleasing. In the case of showrooms, picture galleries, or shops with low ceilings, the plan of placing the lamp above the ceiling will be found very good, much room being thereby saved. We can imagine that in the case of a public hall or large room, with these lamps ranged around the walls, and the light thrown up to the ceiling, especially if the latter had sloping sides, the effect would be very good.

When lamps of the pattern shown in Fig. 4 were used for other than workshop or factory lighting—*e.g.*, in concert halls, assembly rooms, shops, etc.—the underside of the shade and the case containing the lamp mechanism could be concealed by some floral design in wrought metal-work, and the lamps would then look very ornamental.

When the ceiling is too high to reflect the light with advantage, a large umbrella-like shade is placed above the lamp, by which means the light is reflected downwards. In this case, however, the diffusion of the light would not be so perfect.

Although we are not aware that inverted arc lighting has yet been applied to domestic work, we see no reason against its adoption, as there are many patterns of small-current arc lamps on the market which will work two in series off 100-volt mains. There should be no difficulty in adapting one or other of these patterns to inverted work, or a smaller size of the particular make of lamp shown in Fig. 4 might be turned out. The low white ceilings of the generality of houses would lend themselves admirably to such a method of illumination, and we confidently look forward to this as a future departure in domestic interior lighting.

(To be continued.)

EXTRAORDINARY ACCUMULATOR.

Our contemporary *L'Industrie Electrique* has actually unearthed from the columns of a French medical journal a brilliant accumulator, which it has added to its "Old Curiosity Shop." But let this specimen speak for itself; it would be a pity to destroy the lucidity and scientific accuracy of the text:

"The new pamphlet concerning the accumulators is on sale at our offices, where our Paris readers can obtain it by sending one franc. Nothing has been neglected theoretically to explain clearly the object and advantages and to give readers the most detailed explanations about this new apparatus. Our experimental batteries have given such results that we have no hesitation in stating that we have ourselves been surprised at the quality of formation and duration. The accumulation increases, so to say, at a glance. One of the things which have most surprised the engineers who recently witnessed the erec tion of the accumulators is their immediate working, even before being charged with electricity. In effect, their sole manufacture contains the necessary materials for the production of electricity; this, notwithstanding all ancient theories, constitutes a powerful grate of reconstitution struggling against the losses of fluid. Nevertheless, we have desired to leave nothing to chance and reckon even for that loss which seems every day to become less." As the Brothers Griffiths would say, "Chose extraordinaire." We would recommend this masterpiece to the conductors of *Tit-Bits* or *Answers*.

LARGE ARC DYNAMOS.*

BY C. N. BLACK.

Glancing back over the last 15 years and noting the rapid progress made in all branches of electrical engineering, it appears strange that arc dynamos have met with so few changes, more especially so when we remember that arc lighting was one of the first branches of the science reduced to practical use on a large scale. It is impossible to ascribe this to the fact that there was nothing left to be desired in the design or the efficiency of this type of machine, since it has always been notoriously weak in respect to efficiency, and has by no means kept pace with the incandescent dynamo. Within the last 18 months, however, various manufacturers have awakened to this fact, and we have seen the results in numerous descriptions of arc dynamos appearing from time to time in the technical journals. The general tendency seems to be toward larger units and lower speeds; but although the increase in size has, of course, increased the efficiency to some extent, we still notice the massive field magnets with their enormous amount of copper and the small armature, which alone is enough to account for the inefficiency of these dynamos. Another noteworthy fact is that, with one exception, which, perhaps, I need not mention, all the new machines thus far described are of what is known as the closed-coil type. This is the more remarkable when we consider that fully 75 per cent. of the arc lights in this country are run from open-coil dynamos. The open-coil dynamo at the very earliest date appealed to such men as Charles F. Brush and Elihu Thomson as being especially suited for this constant-current work, and, by the remarkable genius of these pioneers, was so perfected that to-day machines with scarcely a single alteration from the design of 15 years ago are being sold in competition with the latest closed-coil dynamos.

The question as to the reasons for this preference natu-

* Paper read before the National Electric Light Association at Cleveland.

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rally suggests itself, but before answering it, I will briefly describe some of the most marked points of difference between the two classes of machines. As the name implies, the open-coil machine has the separate coils or sections of the windings of the armature entirely distinct one from another. In other words, they do not form a closed circuit. In the open-coil armature each coil or bobbin, as it is generally called, has a large number of turns, and there are but few commutator segments, while in the closed-coil armatures we have exactly the reverse—namely, a few turns per coil, and a large number of commutator segments. This is due to the different manner in which they commutate. In the open-coil machine a large amount of self-induction in each bobbin is by no means objectionable; in fact, one might almost say that it is essential in order to obtain the best results, while in the closed-coil machine the less self-induction there is in each bobbin the better the action at the commutator. The latter is true of all closed-coil machines, whether for arc or incandescent lighting, as all engineers well know who have had any experience in the designing of dynamo-electrical machinery.

The first statement, however, is not nearly as well understood even among those who have had considerable experience with the open-coil machine. The fact that a large amount of self-induction is advantageous in an open-coil machine has never to my knowledge been stated before, although on it depends the successful working of a machine of 2,000 volts or more. Silvanus P. Thompson, in his "Dynamo-Electric Machinery," gives a very clear account of the manner in which an open-coil machine commutates.

To one unfamiliar with the open-coil dynamo it is always a matter of wonder that the commutator spark does not cut away the segments. As a matter of fact, it does so to a certain extent, but the current is so small, and whatever heat there is is radiated so rapidly, that the effects in practice are almost inappreciable. At this point the self-induction of the bobbin plays an important part. Were it not for this, the current in the bobbin which is being cut out would be reversed before the segment had reached a sufficient distance from the brush to prevent the current jumping back across the heated air-space, and thus causing the machine to flash.

The design and proportioning of the field magnets are the same as in the closed-coil machines. It is in the commutator and commutation, then, that we find the most marked difference between the open and closed coil arc dynamos, and herein lies the great superiority of the former over the latter. Take, for example, a new open-coil 125-lighter and one of the latest closed-coil 100-light machines. In the one there are 24 segments in the commutator, while in the other there are 160. To go into details as to which is the easier to insulate and keep in repair is scarcely necessary before a society of practical managers and engineers.

Some advocates of the closed-coil dynamo, however, claim that such a small number of commutator segments causes a discontinuity in the current, and consequently a greater strain upon the insulation of the line. This is not a new objection to the open-coil dynamo, and has been answered long ago. It seems, however, to have been revived recently, and I have noticed that one builder of closed-coil apparatus lays great stress upon the fact that its machine generates an absolutely steady current, and therefore puts no undue stress upon the insulation of the line.

In 1887 Mordey, in England, made the following experiments upon a Brush machine, in order to determine how much fluctuation there really was. Six converters, each made to transform from 2,000 down to 100 volts, had all their primary and all their secondary coils joined in series. The current from the Brush machine was sent through all the low-tension coils, and then, with a Cardew voltmeter, he attempted to measure the difference of potential at the terminals of the secondary or fine-wire coil. The pointer, however, remained at zero, showing absolutely no E.M.F. He then applied the wet hands across the terminals of the whole series, but with equally negative results. An experiment which I myself made not long ago confirms fully these results. The current from a closed-coil dynamo, which had 72 bars in its commutator, and which, therefore, gave practically a steady current, was passed through the field coils of a 125-light arc dynamo, and the fall of potential was measured with a Weston voltmeter. The machine was then run self-exciting, and the drop through the field was again taken. The currents in both cases gave identically the same readings on the voltmeter. That there is a discontinuity in the current no one will deny, but that it is so slight that no instrument less sensitive than a telephone will show it, appears to be conclusively proven by the above experiments. This conclusion being reached, it is difficult to understand how the insulation of the conductor would be more strained by an open-coil than by a closed-coil machine.

A much more vital question in connection with these large units delivering current to the line at the enormous E.M.F. of 6,000 volts or more is this: What value will the E.M.F. attain in case the circuit is suddenly broken? From a theoretical standpoint, basing our deductions on the manner in which the two types commutate, the open-coil machine has largely the advantage. Opening the circuit is the same, in one sense, as suddenly throwing a high resistance into the line; and when we do this we shift the point of commutation back under the brush, owing to the reaction of the armature current being reduced. Consequently, the bobbin, which should not be cut until after its segment has passed from under the brush, short-circuits the one in parallel with it, and as a result the segment connected with this bobbin carries the arc around to the opposite brush, thereby causing the machine to flash; this short-circuits the armature, and the E.M.F. drops to zero. This flash is not due to the insulation breaking down at any point, but is simply drawing the arc of a short-circuited bobbin part way round the commutator, and in this way is acting like a safety valve. The machine is not injured in any way, as as soon as the break in the circuit is repaired it is ready to again deliver current to the line. In order to prove this by a practical demonstration and to learn accurately just what value the E.M.F. attained when the circuit was suddenly broken, we made the following experiment. The sparking distances, from 500 up to 9,000 volts, between two carbon pencils, one with a flat end and the other with a rounded one, were accurately determined within a few thousandths of an inch. The curve is almost a straight line, and, let me add, it agrees very well with that obtained by De la Rue and Muller, who made quite an extensive series of experiments upon sparking distances. The terminals of the 6,250-volt machine were then connected to these carbon pencils, and the greatest distance the current would jump on suddenly breaking the circuit was determined. This distance corresponded to a little less than 8,000 volts, showing that the E.M.F. had risen between 1,500 and 2,000 volts. This can be accounted for by the fact that it takes an appreciable moment of time for the arc on the commutator to be carried from one brush to the other. Owing to each segment extending about 60deg. around the commutator, the time required to short-circuit the commutator is just one-third of what it would be in the closed-coil machine, consequently I think the statement that in a closed-coil machine the voltage would rise to fully double its normal value under the same conditions would be a very conservative one; in fact, I have many reasons for believing that it would go considerably beyond this, providing, of course, that the insulation of the commutator did not break down. If this occurred, the machine necessarily would be unfit to run again until repaired. This peculiarity, if I may be allowed to call it such, of the open-coil machine is especially important where underground circuits are employed, since a breakdown in the insulation, due to an abnormal rise in the voltage, is something that can only be repaired at considerable expense.

Knowing that some tests on underground circuits would be of interest to central-station engineers, I arranged, through the courtesy of E. A. Leslie, of the Manhattan Electric Light Company in New York, to make some determinations as to the rise in voltage when a long underground circuit was suddenly broken. A Brush open-coil 125-light machine was connected to a 12-mile underground circuit, supplying current to 125 arc lamps. The voltmeter registered 6,850 volts at the machine terminals. The circuit was then broken a number of times with the carbon

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points in shunt with the break. At first the carbons were separated by a distance corresponding to 10,000 volts, and this distance was then gradually reduced until the current jumped the air-space. This indicated only 5,000 volts. The carbons were then set for 6,000 volts, with the result that the current jumped twice in breaking the circuit eight times, showing that we had about reached the limit. It was then decided to try breaking the circuit near the centre. Under these conditions 5,000 volts was the highest reading we obtained, but there was a marked difference in the time of discharge. In the first case there were two discharges in rapid succession within a half second after the break, while in the second case fully two seconds elapsed before the current jumped. In both cases there were two discharges before the arc was established, the first one being short and snappy, resembling a static spark. From this it will be seen that the capacity of the circuit more than counterbalanced any rise in voltage due to self-induction of the machine and line. With these results before us, we can safely assume that the insulation of the cable will not be overstrained by an accidental break in the line.

All these considerations led the company with which I have the honour to be connected to adhere to the open-coil type of machine in designing its large units. The Brush 125-lighter runs at 500 revolutions per minute, and its rated capacity is 125 50-volt 9·6-ampere arc lamps, or 60 kilowatts. It will, however, give 6,700 or 6,800 volts without undue heating. Its weight, including sub-base, pulley, and regulator, is exactly five tons. The frame proper is made of the best grade of soft grey iron, and is cast in three pieces. The two upper caps can be readily removed, thereby giving free access to the armature, which can be taken out and replaced in a very few minutes, in case of necessity. The journals are self-oiling and self-aligning, with gauge-glasses, so that the amount of oil in the well can always be ascertained at a glance. The field-magnet cores are hammered steel, very low in carbon, and showing very high permeability. The pole shoes are steel castings, tapered at the tips to prevent excessive heating due to eddy currents. No. 8 wire is used in the field, which is two sizes larger than on the majority of arc dynamos of other makes. The current per square inch is only 746 amperes, consequently the temperature rises but little, even after a 24 hours' run. The armature is of the well-known standard type, the only difference being that on account of the machine being four-pole, four bobbins are connected in series instead of two.

We now come to the commutator, that part of all continuous-current dynamos which is a source, directly or indirectly, of more perplexity and trouble than all the other parts combined. Three objects were aimed at in designing the commutator for this machine: first, simplicity; second, durability: third, ease of repair. There are three distinct rings, each one of which is built up in sections of thoroughly dried apple wood filled with boiled linseed oil. Over this is forced a mica ring $\frac{1}{16}$in. thick, and on the sides mica discs protect the wood from the arc. Upon the mica are mounted the brass segments, and on these, in turn, the copper. Lignum vitæ blocks $2\frac{3}{4}$in. long serve for insulating pieces between the segments. The brushes are the tangential type, the same as those used in connection with all open-coil dynamos of this design. An automatic regulator, for shifting the brushes and shunting more or less of the current from the field magnets as the load varies, is fastened to the front of the machine, under the commutator. The small shaft which passes across the front is driven through a worm by a small belt from the armature shaft. On this shaft are mounted two magnetic clutches, which are regulated by two relays in the wall controller. The electrical energy consumed in operating the regulator is less than one-tenth of 1 per cent. of the output of the dynamo. The machine is absolutely automatic, from one lamp to the full capacity, and the whole load may be thrown on or off with impunity.

The characteristic curve of this machine without any regulator is remarkable from the fact that after we get over the bend the curve is almost perpendicular, and is probably the nearest approach to a constant-current machine ever attained. By winding more wire on the armature we could have made this machine deliver a constant current of 9·6 amperes at all loads without shunting any of the current from the field; but this would have increased the internal resistance, and also have made the machine much less efficient at light loads. By the present method of regulation we reduced the C^2R loss at one-quarter load from 4,018 to 3,367 watts, or, in other words, we gain almost 1 e.h.p.

The electrical efficiency at full load reaches 94 per cent., which is accounted for by the liberal allowance of iron in the armature, thus reducing the reluctance of the magnetic circuit, and by the large size of the wire used on both field and armature. At full load the commercial efficiency is over 90 per cent., and approaches very closely the efficiency of incandescent dynamos of equal capacity, but the most noteworthy point is the high efficiency shown at one-quarter load.

A NEW METHOD OF MEASURING ILLUMINATION.*

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

(Concluded from page 376.)

In the same way, the amount of light required to permit the performance of other kinds of work is readily determinable. It is evident, therefore, that our illuminometer is applicable to the determination of the question as to whether the illumination of a given area is, or is not, sufficient for the character of work to be done, and that the measurement of illuminations can be made with a reasonable percentage error for all intensities within the range of the apparatus. This range can be varied by altering the character and dimensions of the window, as well as the character and dimensions of the test object.

It will be evident that the advantage of such an instrument consists in the fact that it entirely dispenses with the necessity for the use of a portable standard of light, thus removing a constant source of unknown error in apparatus previously employed for this purpose. Moreover, the instrument does not require any great skill in its use, and with simple directions for use can readily be employed by an inexperienced observer.

It is evident that our illuminometer will permit a direct determination of the candle-power of a source of light by measuring the illumination produced at a fixed distance by that source of light alone. Thus, for example, if an incandescent lamp has its illumination measured at a distance of one metre from the centre of the filament, the number of luxes indicated by the instrument when its window is perpendicular to the rays from the lamp, and all other sources of light are cut off, will give directly the number of international or decimal candles in the lamp. It is, therefore, possible to measure the candle-power of a lamp in its socket, provided all other lamps in the neighbourhood be extinguished, and that a black non-reflecting cloth be placed so as to prevent any appreciable amount of light from entering the windows, except that radiated directly from the lamp. Our illuminometer, therefore, becomes indirectly a portable photometer. In the use of the instrument care must be taken to keep the glass of the eye-piece and of the window clean, as otherwise the observations may be vitiated. The use of the focussing eye-piece is intended to avoid the necessity that might arise for wearing glasses, by which the quantity of light entering the pupil of the eye from the test object would be necessarily reduced.

Since the indications of our instrument depend upon the physiological effect alone, and not on the contrast of an unknown with a known illumination, all questions as to difference of colour in the illumination to be measured are avoided, so that a measurement of the intensity—*i.e.*, the candle-power of an arc lamp—can be made without employing a special arc standard.

Apart altogether from the use of our apparatus, the National Electric Light Association doubtless recognises the fact that there exists to-day no generally accepted standard of illumination. We would respectfully recommend that the association consider the advisability of

* Paper read before the National Electric Light Association Cleveland, February, 1895.

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adopting as the unit of illumination the lux, or bougie-metre—*i.e.*, the illumination produced by a decimal candle at a distance of a metre. This unit has been under consideration for some years, and has been provisionally adopted by several writers in this country and Europe.

OBSERVER X.—INCANDESCENT LIGHT.

Observations.	No.	Sum.	Mean.	Residuals.		Sum of residuals.	Mean residual
8·5	18	132·4	10·184		1 584	10 016	0·77
9·6					0·584		
9·4					0·784		
11·4				1·216			
12 2				2 016			
9·6					0·384		
9 2					0·984		
10·2				0·016			
10·3				0·316			
9·8					0·384		
10·2				0·013			
11·2				1·016			
10·6				0·416			

Result, 10·184 ; mean error 0·77 (7·56 per cent.).

OBSERVER W. A.—DAYLIGHT.

Observations.	No.	Sum.	Mean.	Residuals.		Sum of residuals.	Mean residual.
47	13	504·5	46·5	0 5		55	5
37					9·5		
50·5				4·0			
57				10·5			
43					3·5		
45					1·5		
38·5					8		
40·3					6		
46					0·5		
55				8·5			
55				8·5			
48					3·5		
47				0·5			
				32·5	32·5		

Result, 46·5 ; mean error 5 (10·75 per cent.).

THE SELECT COMMITTEE ON TELEPHONY.

The committee which is enquiring into the adequacy of the telephone service in the country met again last Friday, the Postmaster-General (Mr. A. Morley) occupying the chair.

Bailie Chisholm, a magistrate and a member of the Corporation of Glasgow, in answer to **Sir C. Cameron**, said that in April, 1893, a special committee of the Corporation was appointed to consider the question of obtaining a license from the Post Office to establish a telephone exchange. The result of their deliberations was that it was resolved to apply to the Postmaster-General for a license, and a license was applied for on August 12, 1893. This was done owing to the very unsatisfactory nature of the service now supplied. There were continual complaints of the difficulty of getting connection and of interruptions in conversation. There was only one way of getting rid of these difficulties, and that was by having a twin-wire system, which could only be established by the company having access to the streets This the Corporation would resist to the utmost, as they had already taken over the gas and water pipes, sewers, tramways, and electric light mains. Therefore great complications would arise if the telephone company had facilities to take up the streets. The National Telephone Company was very heavily capitalised, and that would prevent their lowering their prices. The Corporation, however, could raise money very cheaply, and could afford to work at a lower price. The present subscription was £10, and he was satisfied that with a lower subscription the telephone would be much more used by ordinary citizens. The subscription was £20 some time back, and since the reduction the number of subscribers had largely increased. The price in continental countries, and especially in Stockholm, was much lower. From estimates laid before the committee they believed that a thoroughly efficient service could be given at an annual charge of £5. In the course of the negotiations with the Post Office the Corporation had had no official communication from the Post Office to say that their application would be refused.

The **Witness**, examined by **Mr. Fletcher Moulton**, said that he had not given any special attention to the Telegraph Act of 1892, except in connection with this question. He knew of the provision which required the telephone company to get the consent of the local authority before they interfered with the streets. That was a provision in favour of the local authority which ought not to be tampered with in any way. The agreement between the Post Office and the company required the Postmaster-General to connect by underground wires any exchange when asked to do so. As he understood, the Post Office would not require the consent of the local authority to interfere with the streets when required by the telephone company to connect exchanges. He had read the agreement between the Post Office and the telephone company, and in that agreement, he believed, there was absolutely no protection for the public as to the charges that could be made. That, he thought, was a very unsatisfactory state of things.

Sir J. Goldsmid : Have you taken the trouble to enquire as to the proportion of interruptions to the number of messages ?—No.

Will you take it from me that the number of exchange calls in Glasgow per day for last year was 28,213, and the proportion of complaints 3·79 ?—Yes ; but there are thousands of informal complaints.

You told us just now that the Corporation could have nothing to say to the Post Office if they wanted to go under the streets ?—I still think they have practically no power to oppose them.

Clause 12 of the agreement says that so long as it is in force the Postmaster-General shall, on the request of the company, connect exchanges by underground wires. The method of action is determined by 26 and 27 Victoria, which says that the method in which the Postmaster-General is to carry this out is that he shall consult with the local authority, and, subject to appeal, shall not take his wires under any street except with the consent of the local body having the control of the street. Are you aware of that provision ?

The **Chairman** : I would suggest it would be better to recall Sir Robert Hunter on this point.

Sir J. Goldsmid : It is as clear as noonday. The hon. and learned counsel (Mr. Moulton) got completely off the rail.

In answer to further questions by **Sir J. Goldsmid**, the **Witness** said he had considered the disadvantage to subscribers of being on different exchanges. No doubt many persons would have to subscribe to both where there were two. He had not made any enquiry which satisfied him that the conditions in Stockholm were the same as in Glasgow. In London the area covered was 630 square miles, and he understood that the area covered in Stockholm was 43. He was not aware of the rate of wages paid to operators in Stockholm, but he would take it from the hon. member that it was under 2s. a day. In London it was 5s.

Sir J. Goldsmid : I suppose it is not less in Scotland ?—No Scotchman would take less than an Englishman.

By **Mr. Snape** : A reduction in price unaccompanied by an improvement in the service would certainly not satisfy the Corporation. He did not think that the Corporation would make any difficulty in the event of a license being granted about handing over their undertaking to the Government on reasonable terms on the expiry of the license.

The **Chairman** : You are aware that if I had granted a license, your Corporation would have had to come to Parliament for powers to establish an exchange ?—I believe there is some difference of opinion on that point, but even if that were the case there would be no difficulty about the Corporation's coming to Parliament.

Would your proposal, if you came to Parliament, be to buy up the system of the company as you have bought up the undertakings of the gas and water companies ?—If the telephone company at present had, as the water and gas companies had, the right to lay pipes in the streets that might be necessary ; but that is not intended now.

Have you formed any estimate of the number of subscribers you would secure for your municipal system ?—No, but I am sure the number would double or treble itself if the price were reduced.

Bailie Colquhoun, a Writer to the Signet in Glasgow, a member of the Corporation, and a member of the Telephone Committee, corroborated the last witness as to the unsatisfactory nature of the service at present. He could see no practical difficulty in working two systems in the same area. The Corporation would be prepared to take a license terminating at the same time as the license of the company and to hand over their undertaking to the Government, if they desired to acquire the telephones, upon reasonable terms. In his opinion, the Postmaster-General had a practical right to use the streets. It would be really impossible for the Corporation to prevent him from opening the streets, and under the agreement with the telephone company the Postmaster-General was bound, on the request of the company, to connect exchanges The assent of the Corporation to an interference with the streets by the Postmaster-General could not be with-held except on reasonable grounds, and then there was an appeal to the sheriff.

By **Mr. Fletcher Moulton** : If a social necessity like telephones was to be in the hands of a private company, conditions as to efficiency and a maximum price ought to be imposed. They should be sufficient to secure effective service at a reasonable price. There were no conditions in the agreement of the Post Office with the National Telephone Company to secure the public from exorbitant prices or an inefficient system. Competition was an inefficient check, and, that being so, there was no protection whatever to the public in the agreement. If the municipality had a license, the price charged for the service would be a sum that would bring a fair return to the Corporation, and competing systems would have to bring down their prices to that level. There were three companies and 11,534 subscribers in Stockholm. If the Glasgow service had been efficient at a reasonable rate, Stockholm would not have been in it with Glasgow.

By **Mr. Benn** : He did not think the present policy of the Government consistent with the former Post Office policy.

By **Mr. Tully** : He did not think that the granting of municipal licenses would have any serious effect on the revenues of the Post Office. The use of telephones did not injuriously affect the telegraph service.

Sir J. Ferguson : Are you aware that in America, where telephones have been very much developed, they are all in the hands of private companies, and not in the hands of municipalities ?—Yes ; but we all know what sort of municipalities they are in America.

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By the **Chairman**: If the municipality of Glasgow were to get a license the result would be to reduce the price, and that would enable people to subscribe to both exchanges without any increase of cost. There would also be the advantage of the twin-wire system. He was very strongly of opinion that the State should have the telephones. If the State could not take them then the municipalities should be allowed to. He did not think that the granting of municipal licenses would hinder the State from acquiring the telephones, as municipal undertakings would probably be acquired at a much cheaper rate than private undertakings.

Sir James Russell, ex-Lord Provost of Edinburgh, stated that, although the working of the telephones in that city was not so bad as it was in Glasgow, it was very far from satisfactory, chiefly on account of the mixture of voices. He objected to overhead wires because they interfered with the beauty of the city. He had no doubt that the municipality could work the telephones better and cheaper than either a company or the Government. Mr. Graham Bell, the inventor of the telephone, was a native of Edinburgh.

Baillie Anderson also gave evidence, and **Mr. Bisset**, city treasurer of Aberdeen, spoke to the state of things in Aberdeen.

Sir J. Leng, M.P., also gave evidence as the state of things in Dundee.

The committee adjourned.—*The Times.*

HANLEY ELECTRICITY WORKS.

The following particulars have reached us concerning the working of the Hanley electricity works, which were opened in July of last year:

Loans sanctioned, £22,000; capital expended on December 31, £21,145; capacity of plant on December 31, 650 i.h.p.; number of 32-watt lamps fixed on December 31, 8,732. (This does not include the markets, which are all wired, but not connected to mains pending the erection of more power.)

Units delivered to customers	55,086	65,871.
,, ,, public arc lighting	10,785	
Revenue from supply of electricity—		
Current per meter	£1,339	£1,574.
Public lighting	170	
Meter rents	27	
Sale and repair of apparatus	38	

Statutory price, 8d.; price charged (with discounts), 6d.; average price obtained, 5·83d.

Cost of Production, etc.		Cost per unit delivered.
Coal, etc.	£216	·79d.
Oil, waste, water, stores, and carbons	91	·33d.
Wages	235	·86d.
Repairs and maintenance—buildings, engines, dynamos, mains, lamps, etc.	158	·57d.
Works costs	£700	2·55d.
Miscellaneous Expenses.		
Rent, rates, and taxes	23	·08d.
Salaries of engineers, stationery, and printing, general establishment, and insurances	193	·70d.
Total costs	£916	3·33d.

Profit for year, £658; amount paid as interest, £627; balance carried forward as reserve, £31.

REVENUE ACCOUNT.

Dr. To Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel, including carriage, etc.	216 6 7	
Oil, waste, water, and engine-room stores	63 15 9	
Wages at generating stations	201 9 9	
Repairs and maintenance as follows—buildings, £19. 3s. 6d.; engines, boilers, £30. 16s. 8d.; dynamos, transformers, etc., £11. 0s. 5d.; other machinery, instruments, £10. 1s. 5d.	71 2 0	
		552 14 1
To Distribution of Electricity.		
Wages to linesmen, fitters, labourers...	1 10 11	
Repairs, maintenance, and renewals of mains of all classes, including materials and laying same	0 11 8	
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	68 7 7	
Repairs, maintenance, and renewals of apparatus at distributing stations	2 8 8	
		72 18 10
To Public Lamps.		
Attending and repairs	9 5 3	
Renewals of lamps	5 8 0	
Wages—trimmers	32 3 2	
Carbons	27 7 9	
		74 4 2
To Rents, Rates, and Taxes.		
Rates and taxes		22 10 0
To Management Expenses.		
Salaries, engineer's department	163 19 6	
Stationery and printing	9 17 10	
General establishment charges	3 12 3	
		177 9 7
To Special Charges.		
Insurance, etc.		15 12 6
Total expenditure		915 9 2
Amount carried to net revenue account		626 13 8
Balance carried to next account, to provide for bad debts		31 16 8
		£1,573 19 6

Cr.	£ s. d.	£ s. d.
Sale of current per meter at 6d. per B.T.U.	1,338 17 5	
Public lighting	170 0 0	
		1,508 17 5
Rental of meters and other apparatus on consumers' premises	27 5 11	
Sale and repairs of other apparatus	37 16 2	
		65 2 1
		£1,573 19 6

STATEMENT OF ELECTRICITY SOLD, ETC., YEAR ENDING DEC. 31, 1894.

Quantity generated in B.T. units		77,854
Quantity sold—public lamps	10,785	65,871
,, private consumers, by meter	55,086	
Quantity used on works		1,450
Total quantity accounted for		67,321
Quantity not accounted for		10,533
Number of public lamps (8-ampere arc lamps)		30
Total maximum supply demanded in 8-c.p. lamps (32 watts) for private lighting		8,732

PORTSMOUTH ELECTRICITY WORKS.

We have received a copy of the accounts of the working of the Portsmouth central electric light station for the period ended with December 31, 1894. Below are given the revenue account, net revenue account, and general balance-sheet:

Dr. NET REVENUE ACCOUNT.	£ s. d.	£ s. d.
Balance from last year		1,193 19 9
Interest on redeemable stock—Debt accrued due to date	£1,714 8 10	
Amount transferred to loans fund and accrued to date	1,567 9 2	
		3,281 18 0
		£4,475 17 9

Cr.	£ s. d.
Balance brought from revenue account	1,514 9 3
Interest on money on deposit	80 2 8
Balance	2,881 5 10
	£4,475 17 9

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1894.

A.—To Generation of Electricity. Dr.	£ s. d.	£. s. d.
Coal, or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	499 2 7	
Oil, waste, water, and engine-room stores	233 12 11	
Wages at generating station	376 18 5	
Repairs and maintenance as follows: engines, boilers, dynamos, exciters, transformers, motors, etc., other machinery, instruments, and tools, accumulators and accessories	60 5 11	
		1,169 19 10
B.—To Distribution of Electricity.		
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of materials and lamps sold, as *per contra*		12 12 0
C.—To Public Lamps.		
Attending and repairs, including materials supplied		131 15 2
F.—To Management Expenses.		
Salaries—viz., Engineers' department.	£292 8 8	
Accountant and clerical staff	66 14 10	
Stationery and printing	47 8 0	
General establishment charges	52 2 9	
		458 14 3
Total expenditure		1,773 1 3
Amount carried to net revenue account		1,514 9 3
		£3,287 10 6

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Cr.	£	s.	d.
Sale of current by meter at 6d. per B.T.U.	2,059	8	2
Public lighting	1,074	19	0
Rental of meters and other apparatus on consumers' premises	37	3	4
	3,171	10	6
Stores on hand, December 31, 1894	116	0	0
	£3,287	10	6

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	56,385	0	0
Sundry creditors	260	18	3
Amount due to treasurer £5,051 10 8			
Less amount in treasurer's hands on capital account 535 3 0	4,716	7	8
	£61,362	5	11

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	56,049	17	0
Stores on hand at December 31, 1894—coal, £42. 10s.; oils, waste, etc., £63. 10s.; general, £10	116	0	0
Sundry debtors for current supplied to December 31, 1894	2,315	3	1
Balance to debit of net revenue account	2,881	5	10
	£61,362	5	11

COMPANIES' MEETINGS AND REPORTS.

SHEFFIELD ELECTRIC LIGHT AND POWER COMPANY.

The annual meeting was held on Wednesday at the Cutlers' Hall, Alderman Franklin, chairman, presiding.

The **Chairman**, in moving the adoption of the report and balance-sheet, made a reference to the statement of profit of the Company for the past year. A balance of £585 was brought from 1893, and there was a small balance from the suspense account of £146. 19s. The profit for the last year (£1,943) brought the total to £2,675. This had been reduced first of all by the payment of interest on debentures, which was a new item coming into the report for the first time this year; the proportion of formation expenses written off (£202); and the transfer to the depreciation fund of the very substantial sum of £1,250. The shareholders would see that these sums absorbed £2,143, and left a balance of £531. The first thing that would strike them on looking at the accounts was the obvious position that there was no dividend, but having first of all consoled themselves for that disappointment, the more they looked at the accounts the more the shareholders must feel abundantly satisfied. In whichever way they looked at the progress of the Company, they had, he thought, every reason for encouragement. The profit for 1893 was only £830, whereas for 1894 it was £1,943. No provision whatever was last year made for depreciation, and therefore it came to be a question this year as to whether they should not once for all tackle the question of depreciation in order to put the finances of the Company on the soundest possible basis. At the end of 1892 the 8-c.p. lamps wired numbered 7,734, at the end of 1893 they had increased to 8,419, and at the end of 1894 to 15,672. The electricity supplied in 1892, taking 12 months' supply on the basis of the nine months, was 122,000 units, in 1893 it was 131,000 units, and in 1894 192,000 units. The shareholders would bear in mind that practically it was only nine months ago since the new electric light station was inaugurated and the new system of underground mains started, so that they had only had the benefit of nine months of that capital expenditure coming into that year's revenue account. Therefore he thought that, bearing that fact in mind, and also seeing the remarkable progress which had been made by that very young industry in Sheffield, they had every cause for satisfaction. There was another important side of the account—one that occasioned the directors the greatest possible anxiety—the question of capital expenditure. There was nothing more easy than to spend money for the purpose of getting well in advance of capital requirements, but when they bore in mind that dividends had to be earned upon that capital they would see at once that it required very considerable judgment to be brought to bear in order to come to a right decision. The capital expenditure of the Company during the past year amounted to £17,251, as against £19,689 in 1893. A large portion of that money had been spent in the extension of the Company's mains to the West-End and forward to Ranmoor. The directors were now proposing to lay mains along Clarke-house-road and in the district of Broomhall Park, and instructions had already been given for that work to be done. The shareholders would see that in the very nature of the business there must be a constant expenditure of capital, because wherever the Company spread its nets in order to catch customers, there, of course, money was needed. The directors felt that a dividend had been earned, although it was not being paid, and that the position of the Company, having regard to the depreciation which had been met, might be considered satisfactory. In considering the question of the electric light and its great competition with gas, it must be remembered that the former in its earlier stages was competing with gas in its older age and more efficient stages. Gas to-day stood at about 2s. 2d. per 1,000 cubic feet in Sheffield. He concluded with the expression of a hope that under all the circumstances—the short length of time that the company had been in existence, and the undoubted fact that the experience of gas companies in their earlier years was such as to yield no dividend to their shareholders for many years—they would see they were within measurable distance of dividend.

Mr. Vincent Eadon seconded the adoption of the report, and believed the directors had dealt with the profits in the right way.

The report was unanimously adopted.

On the motion of **Mr. William Stephenson**, the remuneration of the directors, exclusive of the managing director, was fixed at £240 per annum. The retiring directors, Messrs. George Senior and William Tasker, were re-elected. The auditors, Messrs. T. G. Shuttleworth and Son, were also reappointed.

EASTBOURNE ELECTRIC LIGHT COMPANY, LIMITED.

The annual general meeting was held last week, under the presidency of Mr. George Boulton (chairman).

The **Chairman**, in moving the adoption of the report and balance-sheet, said that they would see by the report that a dividend was now offered, which represented an increase on last year. The report and balance-sheet spoke for themselves. It was stated that the Company had an increase this year both in arc and incandescent lamps. In arc lamps there had been an increase of eight, and in incandescent lamps an increase of 2,179. The earnings for the year amounted to £5,910 and the expenditure to £3,337, giving the actual working profits of the Company £2,573. After adding to the reserve £295 of last year's profits, and providing for all mortgage and debenture interests, a balance of £1,540 still remained. Out of this they proposed to set apart a sum of £300 to form the nucleus of a reserve fund. A balance in hand then remained of £1,240, and the directors proposed that a dividend of 7½ per cent. per annum, free of income tax, be declared upon the share capital of the Company. The balance of £441 would be carried to next year's revenue account. The depreciation fund account was £1,825. Since the last annual meeting of the Company circuits had been extended to Upperton, the first lighting of which district took place on October 10. The capital for the Upperton extension had been provided by issue of debentures which had been privately subscribed. The Company's machinery and mains were in excellent condition. They had been taking another matter into consideration—viz., the helping of their customers. They did not think they ought to take all the profit to themselves. They proposed, therefore, to reduce the price of lighting from June 30 next from 9d. to 8½d. per Board of Trade unit. He then moved the adoption of the report and accounts.

Councillor Skinner, in seconding, spoke in a hopeful vein of a continuance of its present prosperity. There was not the slightest doubt that next year, instead of the dividend being 7½ per cent., it would be 9½, and probably 10 per cent.

The report and balance-sheet were then adopted.

On the motion of the **Chairman**, seconded by the **Mayor**, a dividend of 7½ per cent. was formally declared. Mr. J. A. Skinner was re-elected as a director.

Mr. F. Hollins proposed a remuneration of £200 to the directors for their services during the past year, and expressed the thanks of the shareholders with the way in which they had managed the work of the Company. **Colonel Peirson** seconded, and the resolution was adopted.

A vote of thanks to Mr. Wilkinson (engineer) and Mr. Towner (secretary) concluded the meeting.

ALTRINCHAM ELECTRIC SUPPLY COMPANY, LIMITED.

The first annual meeting has been held at 33, Brazennose-street, Manchester, Mr. F. B. Ross presiding.

The **Secretary** (Mr. J. E. Sharples) submitted the report of the directors, which stated that the public lighting of Altrincham and Bowden was commenced on January 1, and had proved in every way most satisfactory. There seemed every prospect of the Company obtaining plenty of customers.

The **Chairman**, in moving the adoption of the report, said that the work of laying the mains was begun towards the end of last September, and at Christmas the three feeding centres (Old Market-place, St. Margaret's Church, and Old Bowden Church) had been connected with the Broadheath generating station. The total length of cable laid was upwards of 14,000 yards. A very gratifying amount of support had been accorded by the public, and the light had given general satisfaction. At present there was connected with the mains an actual equivalent of 2,552 8-c.p. lamps. It was estimated that before the commencement of the next lighting season the number would be at least 5,000. That would be sufficient to pay all the expenses of the Company, and then they would begin to think of dividends. They had received considerable opposition from the gas company, which he thought would not redound to the credit of the gas company. He did not see that the gas company would suffer by their success; there were so many ways in which gas could be used.

Mr. W. P. J. Fawcus, in seconding the motion for the adoption of the report, said he had no doubt that when they got more customers they would be able to reduce the price of the light. There was no reason why electricity should not be produced cheaper than gas, and he looked forward in a few years to the price being reduced from 7d. to 4d. per unit.

The report was adopted.

Mr. F. B. Ross and Mr. W. P. J. Fawcus were re-elected

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directors, and a sum of £100 was voted to the directors for their services.

ANGLO-PORTUGUESE TELEPHONE COMPANY, LIMITED.

The ordinary general meeting was held last week at the offices, New Broad-street, Sir Alexander Armstrong presiding.

The **Chairman**, in moving the adoption of the report, said he thought the condition of the Company was very satisfactory. After making all deductions, and including the balance brought forward, the amount to the credit of profit and loss account was £10,629. They proposed to place £6,500 to reserve account, increasing it to £20,000, and to carry forward the balance of £4,129. The expenditure on capital account during the year had been £3,226. On December 31 they had 1,178 paying subscribers in Lisbon and 1,199 in Oporto, representing a gross annual value of £15,638, and with the increase which had taken place during the present year their income was now about £16,000 a year. In view of the depressed financial condition of Portugal he thought it was very satisfactory that the progress of the telephone in that country had been in every way successful, for since its introduction its use had gradually continued to increase year by year. Their loss by exchange last year was £2,241, which was really equivalent to 4½ per cent. on their share capital. This loss and the expenditure on capital account had tended to cripple their resources, but still the Company's position was a sound one, and they looked forward at an early date to being able to pay a satisfactory dividend.

Mr. C. L. W. FitzGerald seconded the motion, which was adopted.

DIRECT SPANISH TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting was held last week at Winchester House, Mr. Edmund Etlinger presiding.

The **Chairman** stated that the balance to the credit of revenue account—£4,076—was smaller than they had been accustomed to, and it was £919 less than the balance for the December half of 1893. This was not owing to any increase in their expenses, which, in fact, had been £348 less altogether, but was simply owing to the traffic having been poor. The total receipts had been £10,477, or £1,268 less than in the December half of 1893. He might state that, as regarded the current half-year, an improvement was shown, for while they had small losses of traffic in January and February, they had had an increase in the present month of £485. The outstanding accounts due to the Company included a certain amount which they had claimed from the owners of the ship "Caloric" for the damage done to their cable. Since the publication of the report the action had been tried, and had gone against the Company. The matter was very important not only to their Company, but to all who were connected with telegraphy, for it established certain things by authority of law which, he thought, were not dealt with before. He would not comment on the case, as he was not prepared to say that the matter had yet been finally settled. He concluded by moving the adoption of the report.

Mr. J. Denison Pender seconded the motion, which was carried.

WILLANS AND ROBINSON, LIMITED.

Directors: Mark Robinson, M.I.C.E. (chairman), Sir Gilbert A. Clayton-East, Bart., Captain H. Riall Sankey, R.E. (Ret.), M.I.C.E.

Second half-yearly report of the directors, to be submitted to the shareholders at the ordinary general meeting of the Company, to be held at the City Terminus Hotel, Cannon-street, E.C., on Wednesday, April 10, 1895, at 3 p.m.

The business of the Company continues to increase in a satisfactory manner, as is shown by the following figures:

	First half of year.	Second half of year.	Whole year.
Indicated horse-power of engines ordered in 1893 (old company)...	9,290 ...	9,660 ...	18,950
Ditto ditto 1894	10,815 ...	15,809 ...	26,624

The orders for 1893 greatly exceeded those for any previous year of the old company's existence, and the shareholders will be glad to see that that increase has been not only maintained, but improved upon in 1894. After writing off £2,870. 1s. 9d for depreciation, and providing for interest upon the debentures, the balance to the credit of profit and loss account for the half-year is £8,520 1s. 9d. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 7 per cent. per annum upon the ordinary shares (the same as last half-year), together amounting to £6,006. 3s. 10d.; £754. 3s. 4d. is payable to the directors, in accordance with the articles of association, and it is proposed to carry the balance, £1,759. 14s. 7d., to the reserve fund, raising the latter to £2,646. 9s. 11d. The sum available would be sufficient to pay a dividend upon the ordinary shares at the rate of about 11 per cent. per annum, but the directors feel sure of the concurrence of the shareholders in the view that, at this early stage of the new Company's business, the rapid building up of a substantial reserve fund is an object of greater importance than the payment of high dividends. Owing to unavoidable legal delays the Company has but lately acquired possession of the site selected for the extension works; there is, therefore, little probability that the new works will add to the Company's facilities for producing engines during the present year. Pending the completion of new works, the business is necessarily carried on under disadvantages which act very unfavourably upon cost, and therefore upon profits. The restricted space at Thames Ditton, and the limited number of tools available, in proportion to the increasing business, make that increase a matter as much of embarrassment as of gain. It is, nevertheless, a fact full of encouragement for the future. The site selected is at Rugby, about half a mile distant from the station and adjoining the main line of the London and North-Western Railway, with which it will be connected by a siding. About 28 acres were purchased, but of this five acres have been resold as building land. As a temporary measure, premises have been rented at East Molesey for the storage of patterns, etc. A few tools have also been purchased and fixed there, in aid of the works at Thames Ditton. The increase in rent and taxes is due to this cause. There are some other increases in general charges, some of a temporary nature, and others due to increased work. Orders have been taken for some of the Company's water-tube boilers (Niclausse's patent), which are now in course of manufacture at Thames Ditton; but any large development of this business must be postponed until the works at Rugby are completed.

Dr. BALANCE-SHEET, DEC. 28, 1894.	£	s.	d.
Capital account— Authorised.			
30,000 6 per cent. cumulative preference shares of £5 each	150,000	0	0
30,000 ordinary shares of £5 each	150,000	0	0
60,000	300,000	0	0
Issued.			
20,560 6 per cent. preference shares of £5 each £102,800 0 0			
Less instalments in arrear 157 10 0	102,642	10	0
19,381 ordinary shares of £5 each 96,905 0 0			
Less instalments in arrear 189 0 0	96,716	0	0
	199,358	10	0
Debentures charged on the undertaking	9,910	0	0
Mortgage on freehold property	9,600	0	0
Sundry creditors	8,047	2	8
Reserve fund	886	15	4
Profit and loss account	8,520	1	9
	£236,322	9	9

Cr.	£	s.	d.	£	s.	d.
Freehold property, Ferry Works, Thames Ditton—as per last balance-sheet, June 29, 1894	23,085	16	6			
Additions during the half-year	31	5	3			
	23,117	1	9			
Less depreciation written off	416	4	10	22,700	16	11
Freehold property at Rugby—payment on account				620	0	0
Plant and machinery—as per last balance-sheet, June 29, 1894	41,995	1	6			
Additions during the half-year	1,492	18	8			
	43,488	0	2			
Less depreciation written off	1,743	16	0	41,744	4	2
Patents—as per last balance-sheet, June 29, 1894	10,630	19	0			
Additions during the half-year	365	13	1			
	10,996	12	1			
Less written off	1,160	0	11	9,836	11	2
Purchase of goodwill of business				37,879	14	11
Work in progress on Dec. 28, 1894	23,788	1	2			
Deduct payments by customers	822	8	10	22,965	12	4
Materials and stores and own manufactured stock articles	23,294	7	0			
Engines in stock	4,510	1	9	27,804	8	9
Debtors				44,861	10	4
Investments in names of trustees for debenture sinking fund— Canadian Pacific Railway first mortgage debenture bonds	926	11	0			
2½ per cent. consols	3,725	0	0			
Hobart Electric Tramway Company, Limited, debentures	1,280	0	0			
Kelvinside Electricity Company, Limited, shares and debentures	354	0	0			
Gordon Hotels, Limited, perpetual debenture stock	1,798	9	6			
Savoy Hotel, Limited, perpetual debenture stock	1,809	8	0	9,893	8	6
Investment on account of reserve fund—Royal Brewery (Brentford) first mortgage debentures				861	2	0
Cash—at bankers	17,017	11	2			
In hand	137	9	6	17,155	0	8
				£236,322	9	9

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PROFIT AND LOSS ACCOUNT, HALF-YEAR ENDING DEC. 28, 1894.

Dr.	£	s.	d.
Rent, rates, and taxes	292	14	8
Mortgage interest	206	5	0
Salaries, including directors' remuneration	2,551	6	0
Contingent salaries to employés	374	7	2
Fire insurance	118	16	7
Legal and professional charges	345	19	1
Advertising	498	11	2
Books, stationery, and printing	342	4	3
Postages and telegrams	176	19	11
Travelling, hotel, and general charges	428	18	6
Auditors' charges and accountancy	196	19	8
Interest and discount	126	5	6
Interest on debentures	260	1	1
Reserve for income tax	120	0	0
Company's subscription to sick club, doctor's club, and benevolent fund	134	8	10
Depreciation of freehold property, plant and machinery, and patents	2 870	1	9
Balance, being profit, subject to further remuneration of the directors under Clause 90 of the articles of association, carried down	8,520	1	9
	£17,564	0	11
Contingent salaries to directors, as per articles of association	754	3	4
Balance, available for dividend or reserve	7,765	18	5
	£8,520	1	9

Cr.	£	s.	d.
Gross profit for the half-year	17,328	8	7
Interest on debenture sinking fund investments	232	9	10
Transfer fees	3	2	6
	£17,564	0	11
Balance—profit—brought down	8,520	1	9
	£8,520	1	9

EDISON GOWER-BELL TELEPHONE COMPANY OF EUROPE, LIMITED.

The ordinary general meeting was held last week at the offices, 53, New Broad-street, Sir Alexander Armstrong presiding.

The **Chairman**, in moving the adoption of the report, stated that the suit in connection with the Company's patent rights in Belgium, which had been pending for eight years, had at length terminated in the Company's favour, and the Zurich Telephone Company, working in Namur, had been found in damages and costs. In view of this success, and in anticipation of a satisfactory financial recognition of their claims, the actions entered against other infringers were being proceeded with, and they had every reason to expect the same satisfactory result from these actions as that which had attended their suit with the Zurich company.

Mr. C. L. W. FitzGerald seconded the motion, which was adopted.

SOUTHAMPTON ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

Directors: Mr. G. T. Harper (chairman), Mr. J. F. Obree (vice-chairman), Mr. W. H. Mitchell, Mr. G. J. Tilling, Mr. J. F. Albright. Secretary: Mr. J. T. Hamilton.

Report of the directors to be submitted to the ordinary annual general meeting to be held on Monday, April 8, 1895, at the registered offices of the Company, at 4 p.m.

The progress referred at the last annual meeting has been more than maintained, and in consequence the directors are able to report a net profit of £1,014. 12s. 3d., which, after setting aside £100 for depreciation and £100 for directors' fees, and paying interest on loans and debentures, and writing off the balance of the loss last year (£184. 17s. 10d.), leaves £137. 16s. 7d. to be dealt with. Out of this amount the directors recommend a dividend of 6 per annum on the preference shares, and a dividend of 2½ per cent. on the ordinary shares, which will absorb £102. 2s. 6d., leaving £35. 14s. 1d. to be carried forward. As in last year's report, a statement of revenue and expenses is appended:

STATEMENT OF REVENUE AND EXPENSES.

	Lamps (8 c.p.), Dec. 31.	Units sold.	Revenue. £	s.	d.	Expenses. £	s.	d.
1891 (part only)	—	5,469	350	5	11	535	2	1
1892	2 200	35,537	1,153	4	10	1,152	0	4
1893	3,162	53,848	1,606	14	8	1,121	4	8
1894	3,896 2 cranes = 1,500	*85,501	2,491	6	7	1,676	14	4

* Lighting, 76,685; cranes, 8,816; total, 85,501.

The directors have applied for a provisional order, which they are happy to say is now practically secured. The directors who retire from office are Mr. W. H. Mitchell and Mr. J. F. Albright, who, being eligible, offer themselves for re-election. The auditor, Mr. C. Cox, also offers himself for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1894.

Dr.	£	s.	d.	£	s.	d.
A.—Generation of Electricity.						
Coal and other fuel, etc.	476	8	7			
Oil, waste, water, and engine-room stores	79	10	7			
Proportion of salaries of engineers	121	12	2			
Wages and gratuities at generating station	222	3	5			
Repairs and maintenance as follows: buildings, £1. 11s. 9d.; engines and boilers, £112. 7s.; dynamos and exciters, £3. 18s. 4d.; other machinery, instruments, and tools, £9 1s.; accumulators and accessories, £6. 13s. 10d.	133	11	11			
				1,033	6	8
B.—Distribution of Electricity.						
Proportion of salaries of superintendent and officers	43	0	7			
Wages and gratuities of linesmen, fitters, labourers, etc.	117	15	3			
Repairs, maintenance, and renewals of mains	21	2	7			
Ditto, apparatus		5	6			
				182	3	11
E.—Rents, Rates, and Taxes.						
Rents payable	62	0	0			
Rates and taxes	18	12	10			
				80	12	10
F.—Management Expenses.						
Directors' remuneration	100	0	0			
Salaries of consulting engineer and secretary	62	10	0			
Commissions of collector	57	10	2			
Stationery and printing	15	19	2			
General establishment charges	7	8	1			
Auditor	2	2	0			
				245	9	5
G.—Law Expenses.						
Law expenses				4	7	2
H.—Depreciation.						
Depreciation				100	0	0
I.—Special Charges.						
Insurances	25	17	1			
Southampton Gas Company	1	13	6			
Plate-glass breakage	1	5	0			
Lamp renewals	1	11	5			
Bad debt	0	7	4			
				30	14	4
				1,676	14	4
Balance carried to net revenue				814	12	3
				£2,491	6	7

Cr.	£	s.	d.	£	s.	d.
Sale of current per meter	2,414	0	2			
Sale under contract	3	9	0			
				2,417	9	2
Rent of meters	56	8	9			
Connections	11	0	0			
Hire of lamps	3	0	0			
Repairs	0	6	8			
				70	15	5
Transfer fees				3	0	0
Articles, etc.				0	2	0
				£2 491	6	7

Dr. NET REVENUE ACCOUNT.	£	s.	d.
Balance from last account	184	17	10
Interest on debentures accrued to date	193	15	5
Interest on temporary loans accrued to date	298	2	5
	676	15	8
Balance with which it is proposed to deal as follows: preference dividend, £15; ordinary dividend, £87. 2s. 6d.; carry forward, £35. 14s. 1d.	137	16	7
	£814	12	3

Cr.	£	s.	d.
Balance brought from revenue account	814	12	3
	£814	12	3

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account, amount received as per account	8,735	0	0
Sundry tradesmen and others due on construction of plant and machinery, fuel, stores, etc, to December 31, 1894	223	12	1
Sundry creditors on open accounts	3,314	17	9
Directors	100	0	0
Net revenue account, balance at credit thereof	137	16	7
Depreciation fund account	376	19	0
Band overdraft	5,690	18	4
	£18,579	3	9

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Assets.	£	s.	d.
Capital account, amount expended for works as per account	17,395	2	0
Stores on hand December 31, 1894—coal, £5. 9s.; oils, waste, etc., £16. 18s. 8d.	22	7	8
Preliminary expenses	335	12	8
Sundry debtors for current supplied to Dec. 31, 1894	813	12	6
Other debtors	10	8	2
Cash in hand	2	0	0
	£18,579	3	9

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Manchester.—The Lancashire and Yorkshire Railway Company require by the 30th April tenders for the supply of an oil-engine engine packing, signal and telegraph fittings, signal, telegraph and electric light wires, wire, etc.

Stowmarket.—The Urban District Council require by April 15 tenders for lighting the streets of Stowmarket from August 15 next to May 15, 1896, and also for lighting the post office clock. Particulars may be had of Mr. S. Prentice, clerk.

Rangoon.—Tenders will be received by the president of the Rangoon Municipal Committee, not later than November 4, for the lighting of Rangoon by electricity. Tenders should be accompanied by detailed plans, specifications, and estimates, and must state the terms on which the installation proposed will be undertaken. All information regarding the existing system of lighting and the cost, etc., with plan of the town, can be obtained on application to Messrs. Ogilvy, Gillanders, and Co., Sun-court, 67, Cornhill, London, E.C., accompanied by a remittance of £1. 1s. Tenders are to be sent in sealed covers and endorsed "Tender for Electric Lighting, Rangoon." Mr. J. Short, Rangoon, is the secretary of the committee.

BUSINESS NOTES.

Nottingham.—The Exchange Hall is to be lighted by electricity.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,148.

Change of Address.—Mr. E. R. Dale has removed from Sherbourne to St. Edmund's Electric Works, Salisbury.

Removal.—Messrs. Fuller and Co. have removed from Mansion House-chambers to 28, Bush-lane, Cannon-street, E.C.

Direct Spanish Telegraph Company.—For the month of March the receipts were £2,883, as against £1,809 for the same period of 1894.

Newcastle.—The Walker District Council have approved of the plans of Messrs. Parsons and Co. for the extension of their fitting and machine shops.

West India and Panama Telegraph Company.—The receipts for the two weeks ended March 31 were £17 less than for the corresponding period of 1894.

Globe Telegraph and Trust Company.—The directors announce an interim dividend of 3s. on the preference and 2s. 3d. on the ordinary shares.

Fire.—A fire which took place at Millwall on Tuesday morning practically destroyed the premises of Messrs. Statter and Co., electrical engineers, in Cuba-street.

Yeadon (Yorks.).—Mr. Francis H. Medhurst has been called in to advise the District Council on the tenders which have been received for the electric lighting of the town.

Agency.—Messrs. Munro and Mackintosh, of 97, Union-street, Glasgow, have been appointed sole agents in Scotland for the sale of carbons manufactured by Messrs. Richter's, Limited.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 31st ult. amounted to £1,002, as compared with £841 in the corresponding week of last year.

Direct United States Cable Company.—The Board have resolved upon the payment of an interim dividend of 2s. per share, free of income tax, being at the rate of 2 per cent. per annum, for the quarter ended March 31.

Queenstown.—A scheme for the lighting of the port of Queenstown by electricity has been submitted to the Town Commissioners. The estimated cost of the plant, including the building, engine, generator, etc., is about £6,000.

Leeds Tramways.—The House of Lords Standing Orders Committee have decided to allow additional provisions to be added to the Corporation Bill empowering the use of certain sites for stations on which to produce electrical energy.

Dover.—At the request of the Mayor, the Town Council last week decided that, as the electric light works will shortly commence work, the Board of Trade should be requested to send an inspector to enquire into the safety of the wires, works, etc.

Shoreditch.—The London County Council on Tuesday granted an application from the Shoreditch Vestry for a loan of £2,000 on the annuity system for 55 years for purchase of property to widen Bowling-green-walk, and to provide a site for an electric light station.

Eton.—The provisional order granted by the Board of Trade under the Electric Lighting Acts to the borough of New Windsor, in respect of the borough of New Windsor and the Eton urban district, was produced by the clerk at a meeting of the Eton Urban District Council last week.

City and South London Railway.—The receipts of the Company for the week ended March 31 were £932, against £843 for the corresponding week of 1894, or an increase of £89. The total receipts for the current period of the present half-year are £12,648, against £12,035 in the corresponding period of 1894, an increase of £613.

Kendal.—The Town Council had under consideration last week a recommendation of the Electric Lighting Committee in their minutes with respect to the Windermere order, that in opposing it the Corporation should undertake to apply for a provisional order not later than the session of 1897. The minutes were confirmed.

New Zealand Electrical Syndicate.—Mr. Justice North has appointed Mr. J. A. Kelman receiver and manager for the debenture-holders of the New Zealand Electrical Syndicate, Limited. It is stated that this has become necessary solely for the purpose of reconstructing the company, and that the creditors of the company will be paid in full.

Agency.—Messrs. Lea, Sons, and Co., of Pengewerne Works, Shrewsbury, manufacturers of specialities in artistic electric light fittings and general art-metal workers, notify us that they have appointed Messrs. Francis and Spilsbury, Mansion House-chambers, 20, Bucklersbury, London, E.C., general electrical agents and suppliers, as their agents for London, the south, south-western, and south-eastern districts of England, and for Ireland generally.

Cheltenham.—The Town Council were last week recommended by the Electric Light Committee to appoint Mr. Matthews (gas examiner) electric light inspector at a salary of £10 per annum, and that he should receive half the fees from customers for testing their meters; that the surveyor erect an arc lamp as an experimental lamp in the centre of the open space in Clarence-street, and that 500 incandescent lamps of 8 c.p., 16 c.p., and 32 c.p. be purchased.

Whitechapel.—On Monday, at the meeting of the Whitechapel District Board, the long-maturing scheme of electric light came up for decision, and, by a vote of 21 to 11 on a division, the scheme of the Streets Committee, which was estimated to cost an outlay of £44,500, was referred back to the committee. The debate was a long and important one, the chief argument used against the installation being the uncertainty as to the total cost of the scheme, and the doubt as to the amount of income to be derived from the supply of the electric light to private consumers.

Hanley.—The next meeting of the council of the Tramways Institute of Great Britain and Ireland was to take place at Hanley yesterday, when some new features in connection with the North Staffordshire tramways were to be inaugurated. A carriage was to be ready for the members of the institute to see it lighted by electricity, and it is intended to light up the whole of the cars on the line by the same means. The application of the electric lighting of the cars has been entrusted to Messrs. New and Mayne, of London, the batteries being supplied by the Electric Power Storage Company.

Eastern Extension Telegraph Company.—The accounts of the Eastern Extension, Australasia, and China Telegraph Company, Limited, to December 31 show, subject to audit, a balance of profit of £170 937 after payment of three interim dividends. The directors now propose to distribute the usual dividend of 2s. 6d. per share, making a total dividend of 5 per cent for 1894, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year. For the month of March the receipts show an increase of £2,019 as compared with the corresponding period of 1894.

Portsmouth.—The Electric Lighting Committee of the Corporation met on Thursday of last week and adopted a scheme of extension embodied in a letter from their chairman (Mr. George Ellis). The latter stated that having been requested by the General Sub-Committee to report on the estimated cost of certain extensions of the system with a view to the reduction of charges to the Corporation for public and to other consumers for private lighting, he had with the assistance of the resident engineer, carefully considered the question in all its bearings, and reported that the capital outlay for these extensions would amount to £21,000.

Keswick.—The Urban District Council have adopted a minute of the Electric Lighting Committee to the effect that the committee declined to recommend the Council to give their unqualified assent to the application of the electric light company for a provisional order from the Board of Trade, and recommended the Council to call a ratepayers' meeting to consider the whole question of lighting the town. At a meeting of the Council last week the Council decided to form themselves into committee to obtain information to lay before the ratepayers and to receive any communication that might be received from the electric lighting company.

Bath.—The report of Major Cardew as to the application of the electric light company for a provisional order was circulated on Tuesday. He states that the complaints the local authority have made as to the supply by the present company are justified, and that the company took a too sanguine view as to the rate at which they could produce and supply electrical energy. He recommended that the company be not granted the order unless the Corporation assents to it (such assent having hitherto been withheld), but he expresses the opinion that the Corporation might give that assent provided it is guaranteed powers of purchase, with transference to it of the powers and obligations of the order.

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Bangor.—It appeared from the Water and Gas Committee's report, presented at a meeting of the Town Council on Wednesday, that the committee had had an interview with Mr. Duce, electrical engineer, whose offer was accepted to furnish a full report as to the means and cost of an installation of electric light plant. Mr. Henry Lewis moved the confirmation of the decision come to by the committee, adding that the suggestion had also been made to construct an electric tramway from the town clock to the proposed pier at Garth. The proposal was adopted, as was also another authorising the Council to engage the services of a consulting engineer as soon as they received Mr. Duce's report.

Birkenhead.—The Finance Committee of the Town Council have had under consideration the plans, sections, etc., prepared by Mr. Shoolbred in connection with the erection of the proposed central station. The committee recommended at a meeting this week that Mr. David Lyon, Birkenhead, should be instructed to take out the quantities in connection with the erection of the chimney, and that tenders should be invited for its erection. Mr. T. Cook moved that this be not confirmed, as he considered it would cause confusion if this contract for the chimney was undertaken by one firm and that for the building itself by another. Mr. Byrne seconded. After some discussion the amendment was lost.

Hove Electric Lighting Company.—The Hove Electric Lighting Company, Limited, which was formed in August, 1892, with a share capital of £40,000 in £5 shares, for the purpose of taking over from the Commissioners of the town of Hove, Sussex, the undertaking comprised in the Hove Electric Lighting Order of 1890, and which has laid down the requisite plant and mains at an expenditure of £48,800, and is now supplying electricity to the town, have this week offered for subscription the balance of 2,851 ordinary shares of £5 each and £12,500 of first mortgage 4½ per cent. debentures, the balance of the authorised debenture capital of £25,000. The shares were offered at the price of £5. 5s. per £5 share and the debentures at £103 per £100 debenture.

Belfast.—The Corporation on Monday adopted the report of the Electric Light Committee. Councillor Masterson thought the report was a very meagre one. The electric light had been supplied to a large number of people in the city, and he thought the Council was entitled to some statement as to how the affair was progressing. Alderman Pirrie said they had at present 4 200 lamps actually on supply, and applications for an additional 1,000 were under consideration. This made a total of about 5 300 lamps that were practically being supplied. The average total cost of the supply for the nine weeks was £26. 10s. 2d. per week, and against that there was an income of £27. 15s. He thought that was very satisfactory considering the short time the works had been in existence.

Worcester.—At a meeting of the City Council on Tuesday Mr. Williamson brought up the report of the Electricity Committee on the bill by the contractor for extras in connection with the Powick generating station, which was referred back to them at the last meeting. He said the legal position had been fully considered, and the town clerk advised that though the contract required a written order for extras, if no such order was given, yet after the end of the engagement, if the architect made a certificate allowing such extra work, it was conclusive and final unless his conduct had been fraudulent. There was no suggestion of fraud, and the committee had to inform the Council that they were obliged to pay. He moved the adoption of the report on Mr. Rowbotham's account. Mr. H. Day seconded. An amendment was carried making an addition to the motion.

Lewis v. The London Electric Supply Company. — The question in this case, which came before Mr. Justice Charles and a common jury on Wednesday, was what damages the plaintiff was entitled to as compensation for having been discharged without notice under the following circumstances: the plaintiff was engaged as general manager of the defendant company at a salary of £600 a year, and his engagement continued until the financial difficulties of the company led to the appointment of a receiver on behalf of debenture-holders, when he was cashiered without notice. For the plaintiff it was contended that he was entitled to a year's salary. On the other hand, Lord Wantage, who held the debentures, offered the plaintiff £150, the equivalent of three months' salary, and it was contended that that was a proper satisfaction of the plaintiff's claim. The jury found that the plaintiff was entitled to £300, in addition to £34. 12s. arrears of salary.

Bankruptcy Proceedings.—At the Edinburgh Sheriff Court House last week, before Sheriff Rutherfurd, Messrs. Browning and Gardner, electrical engineers, carrying on business at 122, George-street, Edinburgh, appeared in the Bankruptcy Court for examination in bankruptcy. In reply to questions by Mr. D. W. Marwick, W.S., on behalf of the trustee (Mr. John Hamilton Buchanan, C A.), Mr. Browning said that he had no papers or books, except the vouchers for petty cash expenditure. On December 18, he gave a bill for £60 to Messrs. Anderson and Chisholm, but he was not sure whether that was the day he was gazetted out of the firm. He did not know he was gazetted out of the firm. The bill was granted for a business account. He could not say whether he received a letter from his partner a week before, terminating the contract of copartnery, and he did not know whether it was before or after that that he granted the bill in the firm's name. Sometimes he corresponded in his own name and sometimes in the firm's prior to December. In reply to a question whether the account had been rendered, he said he did not know. The account was in reference to some law business which had been done relating to the business of Browning and Gardner and the financial position of the concern. The firm in October, 1894, showed a surplus of £150, and the trouble was caused because they had not money in hand.—At the London Bankruptcy Court on Wednesday, Mr. Jonathan Lewis Young was examined under his failure. The debtor is an electrical engineer, and started business in partnership with his brother on Ludgate-hill in 1891, trading under the name of the Edison Mimeograph Company. His gross debts are returned at £3,108, of which £2,958 are unsecured, and there are no available assets. The principal creditors are the Edison Phonograph Company, Limited, for £600, and the Bell Phonograph Corporation for £1,760. The examination was concluded.

Arlecdon and Frizington.—The Urban District Council considered at their last meeting a report presented by Mr. J. S. Brodie, of Whitehaven, who had been requested to report on the lighting of the district by electricity. Mr. Brodie found that the only water power available was from Cogra reservoir. This was suitable within certain limits. He had prepared estimates for three separate schemes. First, to take a 9in. main from Cogra to a point nearly opposite Millgillhead, and have there a turbine to drive a dynamo that would supply current to light the public lamps only. Second, to take a 12in. main from Cogra to Marron Bridge (thus obtaining all the power obtainable from water not required for water-supply purposes) and with two turbines and two dynamos to generate electricity, not only sufficient for public lighting, but also to light 500 16-c.p. lamps for private consumers. Thirdly, Mr. Brodie estimated for a steam-power station at Steel Bank to supply the same current as in the second estimate. In each of these estimates the proposal was to replace 127 oil lamps now in use for public lighting by 150 incandescent lamps averaging 20 c p. each. The current in every case would be alternating at 2,000 volts. The report is now under the further consideration of the Council.

Hampstead.—The Vestry had before them at a meeting last week two recommendations of the Lighting Committee on the subject of lighting the High-road, Kilburn. After a long discussion, it was resolved that the Willesden District Council should be informed that the estimated cost of laying down the necessary mains, with lamp standards and fittings for 24 arc lamps in the High-road, Kilburn, was £1,460, and that the cost of running these arc lamps at the present cost price would be £41 per lamp per annum; also that the Willesden District Council should be asked if, in the event of the Vestry agreeing to light the High-road by electricity, they would be willing to pay half of the said estimated cost, and half the cost for the time being, of running the arc lamps. The committee further recommended that the necessary mains, transformers, etc., should be provided for the supply of electric current to private consumers in various localities, in accordance with the plans and specifications of the electrical engineer, Mr. Chattock: West End-lane (Mill-lane to Hemstall-road), £1,420; and Haverstock-hill (Belsize-avenue to Belsize-grove), Belsize-grove, and Belsize-park-gardens at a total cost of £5,260. Mr. Thwaites, chairman of the committee, said that a large number of applications for the supply of current had been received from the tradesmen in the High-road, one of whom wanted as many as 1,000 lights. The recommendation was adopted. A letter was received from Mr. W. H. Preece stating, in reply to the Vestry's enquiry, that if it was intended that the Vestry's own engineer should superintend and carry out plans submitted by him (Mr. Preece), or plans of which he approved, such a procedure was entirely in accordance with his wish, and as he would be freed from the considerable expenditure he was at present incurring he would continue to act as consulting engineer, and ask a commission of only 2½ per cent. on the cost of the work so carried out; but that if by the word "superintend" it was intended that Mr. Chattock should prepare his own plans, submit his own estimates, and act entirely irrespective of him (Mr. Preece) in carrying out the scheme he had designed and reported upon in accordance with the instruction of the Electric Lighting Committee, he should decline to act as consulting engineer on any terms whatever. After some discussion the letter was referred to the Lighting Committee.

Torquay.—The Town Council had before them on Tuesday the report of Mr. W. H. Trentham. M.I.M.E., on the lighting by electricity of the Bath Saloons, Victoria parade, the Strand, and Torbay-road. Mr. Trentham said the total length of underground main required would be 2,442 yards, and if the usual distance, 66 yards, was allowed between each lamp, 37 arc lamps would be required, or a total of 40 arc lamps. The cost of engine, boilers, dynamos, lamps, posts, cables, etc., would amount to £4,900. He had gone carefully into the cost of gas which would be saved by the use of electricity, and on the basis of what was actually now being paid found it amounted to £368 per annum, the nominal candle-power of the gas lamps being 2 300, against 40 000 given by the arc lamps. This amount (£368) deducted from the total expense of running the electric light plant—that was, £728—showed that they would incur an increased expenditure of £360 per annum. He suggested that the installation should be somewhat increased, sufficient machinery being provided to maintain 800 16-c p. lamps in addition to the 40 arc lamps and the incandescent lighting for the Bath Saloons. The total outlay would then be £7,986, and the annual cost of working would be £1,138. On the other hand, there would be a revenue of not less than £866 from the private incandescent lighting at a charge of 6½d. per unit, which was practically equal to 3s. 3d. per 1,000ft. for gas. The capital sum of £7,986 is made up as follows: engines, boilers, and condenser, including steam-pipes, fixing, etc., £1,850; dynamos, transformers, and meters, £1,240; 40 arc lamps and posts, £1,200; street work,

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junction-boxes, and cable, £1,275; battery, switchboard, wiring Bath Saloons, alterations to cellar, travelling crane, etc., £1,350; contingencies at 10 per cent., £691; engineer's fee at 5 per cent., £380; total, £7,986. Mr. Trentham assumes that the cellars under the Bath Saloons would be utilised as a generating station. Alderman Kerswell moved that the report be referred back to the committee. He was glad to see that on the first intimation of the probable introduction of electricity the gas company had lowered the price of gas. Mr. Mortimer seconded. The question they had to decide was not whether they would have electricity in the town or not, but whether they would allow a private company to introduce it or retain it in their own hands. The anxiety of the gas company to prove that electricity would be more costly than gas was, in his opinion, a strong argument in support of the introduction of the new light. He hoped, at any rate, that the town would not allow the installation to pass into the hands of a private company. Mr. R. Crocker supported, and the motion was carried.

PROVISIONAL PATENTS, 1895.

MARCH 25.

6114. **An improved filament for incandescent electric lamps.** Frederick William Edmund Jones, 23, Archery-road, Leamington.

6127. **Improvements in feeding nailing and other machines of that class by means of electricity, and in apparatus used in connection with such machinery.** Robert John Jones, 67, Queen's-road, Bootle, near Liverpool.

6163. **Plate for secondary voltaic battery.** William Alfred Baxter Buckland, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6164. **Automatic cut-out for suspended electrical conducting wires.** Johann Schäfer and Paul Steffens, 28, Southampton-buildings, Chancery-lane, London.

6171. **Improvements in multiple switches for use with double telephonic leads.** Franz Stock, 46, Lincoln's-inn-fields, London. (Complete specification.)

6177. **Improvements in alternating-current dynamos.** William Beedie Esson, Norfolk House, Norfolk-street, London.

MARCH 26.

6192. **Improvements in thermodynamic machines.** William Henry Watkinson, 24, Albion-crescent, Dowanhill, Glasgow.

6256. **Improved construction and arrangement of commutators for dynamos.** John William Gilbert and Samuel Jevons, 77, Colmore-row, Birmingham.

6258. **Improvements in apparatus for the electrolytic decomposition or purification of liquids.** Moritz Stein and Anton Wolf, 433, Strand, London.

MARCH 27.

6318. **New and useful improvements in the method of transmitting electric currents to electric railway cars.** Addison Goodyear Waterhouse, 33, Old Broad-street, London.

6319. **New and useful improvements in electric-current meters.** Addison Goodyear Waterhouse, 33, Old Broad-street, London.

6320. **New and useful improvements in thermostat and electric switches or circuit brakes.** Addison Goodyear Waterhouse, 33, Old Broad-street, London.

6351. **Improvements in dynamo-electric machines.** William Morris Mordey and Silvanus Phillips Thompson, 46, Lincoln's-inn-fields, London.

MARCH 28.

6390. **Improvements in the method of and in apparatus for electrically lighting miners' safety lamps.** John Peel, 8, Quality-court, Chancery-lane, London.

6391. **Improvements in the method of and in apparatus for switching on and off electric currents for electric lighting and other suitable purposes.** Arthur Ballance and Cecil Edward Arthur FitzMaurice, 8, Quality-court, Chancery-lane, London.

6400. **Improvements in and connected with the means of protecting electric conductors.** John Augustine Kingdon, 29, Marlborough-hill, St. John's Wood, London.

6416. **Improvements in ceiling roses for electric light fittings.** Francis William Ball and John Hugh Winter, 65, Chancery-lane, London. (Complete specification.)

6430. **Improvements in conduits for electrical conductors.** James Fulton Cumming and William Clymen Yawkey, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MARCH 29.

6455. **Improvements in apparatus for indicating and recording electric supply.** William Thomson (Baron Kelvin), 154, St. Vincent-street, Glasgow.

6509. **Improvements in apparatus for electrically effecting the reproduction at a distance of graphic matter or designs matter, printed, stencilled, photographed, or otherwise produced.** Rupert Greville-Williams, 22, Southampton-buildings, Chancery-lane, London.

6473. **An improved composition applicable as a substitute for natural cork and for other purposes, such as an electrical insulating material.** Eugène Hermet, 55, Chancery-lane, London.

MARCH 30.

6536. **Improvements in apparatus for producing electrical effects on the stage.** Job Thomas Niblett, 20, Devonshire-road, Greenwich, London.

6545. **An improved electric arc lamp for optical lanterns and other purposes.** George Davenport, 19, John-street, Adelphi, London.

6546. **Improved application of telegraph and telephone circuits.** Samuel Dickinson Williams, Moorlinch House, Clytha-park, Newport, Mon.

6557. **Improved apparatus applicable to the working of electric or lime lights for theatrical purposes.** Samuel Vincent Evans, 4, St. Ann's-square, Manchester.

6565. **Improvements connected with the electrolytic production of alkali and chloride from sodium chloride solution and other substances.** Harry Tee, 8, Quality-court, London.

6575. **Improvements in apparatus for charging portable electrical accumulators or batteries.** Alfred William Bennett, 323, High Holborn, London.

6586. **Electric pneumatic action for organs.** Arthur Price, 162, Market-street, Birkenhead, Ches.

SPECIFICATIONS PUBLISHED.

1894.

4647. **Electric lighting.** Burrell and Fowkes.

4911. **Electric supply apparatus.** Mordey.

5003. **Regulating electric motors.** Aldridge.

5375. **Electromotors.** Statter.

6975. **Battery plates or electrodes.** Smith and Wright.

8317. **Telephone switches.** Lake. (Antwerp Telephone and Electrical Works.)

8823. **Transmitting signals through telegraph lines, etc.** Dearlove.

14246. **Electrical distribution.** Scott.

1895.

1526. **Electric conduit.** Mathers.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅛-2
—— Nom. Cum., 6 per cent. Pref.	2	2⅜-2⅝
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	14⅜-15½
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	130-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2⅞-3⅛
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	100-105
Electric Construction, Limited	2	⅛-⅜
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1⅛-1⅜
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅛-1⅜
Elmore's French Company	2	—
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	⅛-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	9½-10½
—— Preference	—	12
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge	5	7-7⅛
—— 6 per cent. Pref.	5	7-7⅛
Liverpool Electric Supply, Ordinary	5	7⅛-7⅜
—— Pref.	—	—
Liverpool Overhead Railway	10	8½-8⅝
—— Pref.	10	13¾-14
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	⅛-¼
Metropolitan Electric Supply	10	10¼-10⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5⅛-5⅜
—— 6 per cent. Cum. First Pref.	10	15½-16⅛
—— 6 per cent. Cum. Second Pref.	10	14½-15⅛
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7⅛-7⅜
Oriental and Electric Company, £1 shares	1	9/16-11/16
—— £5 Shares	5	7-7⅛
—— £4½ shares	4½	5⅜-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅞-8
—— 7 per cent. Pref.	5	8⅛-9
Swan United	—	—
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7⅛-8
Yorkshire House-to-House	5	5⅛-5⅜

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Oswestry	8,496	1,888	.....	BE J. Bolton	
Peterborough	25,000	1,818	.....	BE J. C. Gill	
Plymouth	85,000	1,395	.....	BE G. D. Bellamy	
Pontardawe	21 700	.....	.....	BE J. Morgan	
Pontypool	6,000	.....	.....	CE J. C. Howell	
Poole	16,500	5,111	... ..	S J. Elford	
Radcliffe	20,020	2,533	.....	S W. F. Pinfold	
Reigate and Redhill	24,000	6,006	.. ...	BE F. D. Clark	
Rochdale	71,400	4,180	.....	BE S. S Platt	
St. Helens	76,300	7,248	6 586 acres	CE R. Hammond BE G. J. C. Broom	H
St. Ives (Hunts.)	3,037	2,330	.. ...	BE W. Wheatley	
Salford	198,139	5,170	.....	CE's Kincaid, Waller, and Manville	H.P.A.,
Salisbury	17,362	908	600	CE R. Hammond	
Southend	12,333	.....	.....	BE C. T. Copley	
South Shields	87,000	.. ...	.....	REE J. A. Jeckell	H.P
Stafford	25,000	8,441	Centre of town	CE Dr. J. Hopkinson REE J. F. Bell	

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NOTES.

Algiers.—The Municipal Council of Algiers have under consideration a proposal to introduce the electric light for street illumination.

St. Pancras Electric Lighting.—A long article on this subject appeared in last week's *London*. It contains a good many inaccuracies.

E.P.S. Batteries.—A new catalogue has been issued by the Electrical Power Storage Company, Limited, with which we shall deal in a future issue.

Electric Crane.—Tests have been made at Havre of the electric crane which has been erected at the Vaubin Dock. The experiments left nothing to be desired.

Electric Lighting in Bombay.—A lecture on electric lighting has been delivered at Bombay by Dr. Kavaria, apparently with an eye to winning over the municipal councillors, who were specially invited to be present.

Electric Lighting in Roumania.—The theatre at Braila, which is connected with the rooms of the Regal Club, is to be lighted electrically. The work has been entrusted to Messrs. Lehmann and Mann, of Berlin.

Lathes, etc.—We have received from Messrs. Koch and Co., 1, Charterhouse-buildings, E.C., an illustrated catalogue of the Triumph precision lathe and other tools for watch and clock makers, engineers, electricians, etc.

New Telegraph Line for the Shan States.—A telegraph survey party for a new line from the Southern Shan States to Kyang Chang, in the neighbourhood of the Siamese buffer State, has been ordered to begin work at once.

Lecture.—In connection with the electrical engineering classes which have been commenced at the Central Schools, Leopold-street, Sheffield, Mr. C. L. Eclair-Heath, Wh.Sc., has delivered a lecture on the application of electricity to industrial purposes.

Electric Lighting in Argentina.—The Intendente is preparing a message for presentation to the Consejo Deliberante, asking for authorisation for installing three new electric light stations for public lighting in various parts of Buenos Ayres.

Book Received.—Messrs. Longmans, Green, and Co. have published "Problems and Solutions in Elementary Electricity and Magnetism," by Messrs. W. Slingo and A. Brooker. This work embraces the South Kensington papers for the years 1885-1894.

Telegraph Hill.—On Friday last Telegraph Hill, Hatcham, was opened to the public as a recreation ground. The name of the hill has nothing to do with electric telegraphy, but was given to it because it was the site of a semaphore station in olden days.

Personal.—On Saturday, 6th inst., at St. Mary Abbotts, Kensington, Mr. W. B. Esson was married to Mrs. L. V. Fairfax. A reception was afterwards given at the Kensington Palace Hotel, De Vere-gardens, at which was to be seen a goodly sprinkling of electrical men.

Electric Transmission at Pilsen.—An electrical transmission plant has been installed in connection with the Ziegler pit of the Blattniz Coal Company, of Nürshau, near Pilsen. This is the first installation of the sort in this district. The work has been carried out by Messrs. Siemens and Halske.

British Association.—In response to a circular issued by the Mayor, Dr. J. H. Bartlett, a meeting was held at the Town Hall, Ipswich, on Friday last, for the purpose of making some preliminary arrangements for the reception of the British Association in September next. There was a large attendance.

The Leicester Station.—The central electric light station at Leicester will be formally opened on the 25th inst. by Mr. Alderman Lennard, chairman of the Gas and Electric Lighting Committee of the Town Council. Sir Courtenay Boyle and Mr. W. H. Preece have signified their intention of being present.

Telephones, Fire Alarms, etc.—The Private Wire and Telephone Installation Company, 110, Cannon-street, have sent us an illustrated catalogue, which contains a few of the best patterns, with prices, so that the public can form their own idea of the cost of private wires and telephone and electric bell installations.

The American Electrical Pool.—The Philadelphia correspondent of the *Times* states that the committees which are making arrangements between the Westinghouse and Edison Electric Companies at New York for "pooling" the patents, and so preventing ruinous competition, have practically completed their agreement.

Telephony in Austria.—In the course of last year 24 towns in Austria were provided with telephone exchanges. As regards interurban communication, nine new lines were brought into operation during the year. There are now altogether 47 interurban telephone lines in operation in Austria, having a total length of 2,643¾ miles.

The Madras Electric Tramway.—Highly successful runs, says the *Indian Engineer*, are being made on the Madras tramway from the power station up to the Custom House. The date of the opening of the line for traffic has not yet been settled, as this will greatly depend upon the time that conductors and drivers, who are now being trained, will take to learn their work.

Telephony in Mysore.—The Inspector-General of Forests having submitted a drawing illustrative of the position of the several telephonic lines proposed to be erected in the vicinity of the Keddahs in the Kadur and Shemoga districts, which has met with the approval of Government, the British Resident has been asked to obtain the sanction of the Government of India for the erection of the above telephonic lines.

Northern Society of Electrical Engineers.—The ballot for new members and associates on April 8 has resulted in the election of Messrs. A. F. Ellis, Corporation electrical engineer, Southport; F. W. Page, Clarendon-chambers, St. Ann's-square, Manchester; and J. Sambidge (of Messrs. J. H. Holmes and Co., Newcastle-on-Tyne) as members; and Mr. J. A. Ormerod (of Messrs. R. Haworth and Co., Salford) as associate.

Presentation.—The employés of the City and South London Railway Company have presented Mr. Thomas Jenkin, the general manager to the company, with a writing-table and an illuminated address in recognition of the services of Mr. Jenkin in obtaining for the servants of the company an interchange of travelling privileges on all the important railway lines in the United Kingdom. The presentation was followed by a concert.

Royal Meteorological Society.—At the ordinary meeting of the society to be held at 12, Great George-street, Westminster, on Wednesday, the 17th inst., at 7.30 p.m., the following papers will be read: "The Frost of January and February, 1895, over the British Isles," by Mr. F. Campbell Bayard, LL.M., F.R.Met.Soc., and Mr. William Marriott, F.R.Met.Soc.; and "Some Hints on Photographing Clouds," by Mr. Birt Acres, F.R.Met.Soc.

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Cable Lines.—The Spanish Government has decided to order an enquiry to be made regarding the construction of a direct telegraph line between the French frontier and Cadiz, giving France direct and rapid communication with Senegal and South America. The cable with the Canaries is now restored. The steamer "Dacia" has left for Senegal to repair the cable between St. Louis and Pernambuco.

Electric Traction in Paris.—The First Commission of the Paris Municipal Council have adopted the conclusions of a report by M. Puch concerning a scheme for the construction of an electric tramway to serve the Montmartre district. This line, which it is proposed to lay down with underground conductors, will commence at the Cadet crossing, and will terminate at the Rue Championnet. The report has yet to be considered by the Town Council.

County Council Tramways Bill.—The Select Committee of the House of Commons presided over by Mr. Roby, resumed on Monday the consideration of the Bill promoted by the London County Council to obtain powers to work any tramways which have been or may be purchased by them. The chairman stated that the committee found the preamble of the Bill proved. They would require a clause giving the Board of Trade power to make by-laws for the Council.

Theory.—Mr. John West, ex-president of the Gas Institute, has been reading a paper before the Manchester Association of Engineers on "The Economical Lighting of Public and Private Buildings, Workshops, etc." He informed that body that with gas at 1s. 9d. per thousand, as at Plymouth, the cost of incandescent electric lighting would be about 11 times as expensive as incandescent gas lighting. Mr. West's paper should have been read to the Marines.

Stage-Lighting.—The new Theatres and Music Halls Committee of the County Council do not seem to be following quite in the steps of their predecessors. The present committee have simply ordered special arrangements to be made at Sadler's Wells Theatre in connection with the limelight tanks. It will be remembered that the last committee, on the other hand, when dealing with the South London Palace of Varieties, ordered the abolition of limelight and the substitution of the electric light.

Institution of Electrical Engineers.—In consequence of the exigencies of their building operations, the Council of the Institution of Civil Engineers have been compelled to place the whole of their premises in the contractor's hands, and no further meetings can therefore be held there for some considerable time. The Institution of Electrical Engineers have consequently obtained permission to hold the remaining three meetings of their session—viz., on April 25, May 9 and 23—at the Society of Arts, John-street, Adelphi.

Signalling through Space.—Prof. J. C. Bose, of the Calcutta Presidency College, who has been experimenting on this subject for some time past, has just succeeded in making some instruments by which extraordinary results have been obtained, says the *Indian Engineer*. Without any connection between the transmitting and receiving stations signals in the form of light, sound, and other phenomena have been reproduced, and even solid walls have not interposed any obstacle to the transmission of these signals.

South-West London Polytechnic Institute.—This institute, which is intended to serve Chelsea, Fulham, and neighbouring districts, is now almost complete. It is situated in Manresa-road, Chelsea. The gymnasium will be open in the course of a few weeks. The lecture-rooms, the schools for domestic economy, the art school, and the laboratories for physics and chemistry, will be ready before the autumn session and all the staff appointed. The polytechnic will be one of the best equipped in London, and is expected to be most successful.

Organised Science Schools.—Mr. Acland, M.P., Vice-President of the Council, on Friday last received a deputation at the Education Office from the representatives of the Association of Head Masters respecting the recent regulations which have been issued by the Science and Art Department with reference to organised science schools. The deputation consisted of Mr. A. Scott, South Shields, president of the association; Mr. W. Dyche, Halifax, secretary; and the Rev. George Towner, from the Carpenters' Company's Institute at Stratford.

Weights and Measures.—The London Chamber of Commerce have received a letter from the London County Council on the subject of the Bill promoted by the Chamber for legalising the use of metric weights and measures for export trade purposes. The Chamber are informed that the Council resolved at its last meeting to do all in its power to secure the passing of the Bill during the present session, and that meantime no instructions have been given to the Council's inspectors to interfere with the use of metric weights and measures in the execution of foreign orders, nor is there any intention to issue such instructions.

"The Dangers of Electric Mains."—This is the title of an article in the *Lancet* in which Major Cardew's reports on the Budge-row and Euston-road explosions are dealt. It is mentioned that "the Vestry of St. Pancras are enjoined, as was pointed out in the *Lancet* of March 9, to provide a through system of ventilation or means for the immediate escape of gas from their conduits and street boxes." This statement is rather misleading. A casual reader would suppose from it that the *Lancet* originated the ventilation recommendation last month, whereas Major Cardew's opinion to that effect was made public considerably prior to that time.

Telephone Charges in South Wales.—A meeting of the Newport Chamber of Commerce has been held at which Mr. Robjent called attention to the notice of the National Telephone Company that from March 1 the rates for trunk line communication between South Wales and Bristol and Birmingham would be doubled, and said he calculated that the change would result in an increased revenue to the company of about £3,000 per annum. He thought it was a gross injustice to the district, and proposed a resolution protesting against the unjustifiable alteration, and inviting the Bristol, Birmingham, Cardiff, and Swansea Chambers to co-operate. Mr. L. B. Moore seconded the motion, which was carried.

New Electric Traction System.—Mr. E. Lachmann, of Hamburg, has sent a communication to the Berlin authorities that he has devised an underground conductor system for electric traction which is both economical and safe. Messrs. Siemens and Halske, it appears have constructed at Charlottenburg an experimental line, a twelfth of a mile long, on this system, which has worked satisfactorily. An extension of the experimental line is to be made to demonstrate its capabilities. It is claimed that the system is as cheap as the overhead Thomson-Houston system. We take these statements from the *Elektrotechnischer Anzeiger*, of Berlin, which, however, does not mention what Mr. Lachmann's system actually is.

A Curious Telephone.—According to an American correspondent of the *Times*, a Standard Telephone Company, with branches all over the United States, has been organised by prominent capitalists of New

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York, Chicago, and elsewhere to furnish a cheap telephone service by a new system. It has a capital of 360,000,000dol., with many subordinate companies. The chief parts of the company's telephone are said to be two pieces of cork and a piece of platinum, and it is further claimed that by its system a message can easily be sent from New York to San Francisco. The company proposes to furnish a telephone service for 25dol. a year. The new company has at its disposal great political as well as financial power.

Iron and Steel Institute.—The spring meeting of the Iron and Steel Institute will be held in London on Thursday and Friday, May 9 and 10 next, in the rooms of the Society of Arts. The presidential address will be delivered by Mr. David Dale, and the Bessemer gold medal will be awarded to Mr. H. M. Howe, the distinguished American metallurgist, who will contribute a paper on "The Hardening of Steel." Mr. Stead, of Middlesbrough, will contribute a paper of great practical importance on "The Effect of Arsenic on Steel"; Mr. Sergius Kern, metallurgist to the Russian Admiralty, will discuss the manufacture of armour-piercing projectiles in that country; Mr. Herbert Scott will communicate a paper on "The Iron Ore Mines of Elba"; and Mr. W. J. Keep, of Detroit, will contribute a paper on "Tests of Cast Iron."

Apparatus for Telegraphs, etc.—Mr. G. Straus, 130, Queen Victoria-street, E.C., has issued a new illustrated catalogue of apparatus and accessories for telegraphs and telephones. Among the apparatus referred to are a microphone installation for domestic use, comprising microphone, model of German G.P.O., receiver, automatic switch, call bell, push, and three terminals for working over distances up to 325 yards; microphone installation for domestic use, with carbon grain microphone, the remainder identical with the former; and a microphone installation for domestic use, comprising carbon grain microphone, spoon-shaped receiver, automatic switch, 3½in. call bell, push, and four terminals. A portable electric signalling apparatus with "Reform" bells is also a novelty. It is worked in connection with dry cells.

Commercial Education. — The secretary of the London Chamber of Commerce informs us that as a result of its experience, extending over the last five years, in securing the school training of youths under the Chamber's commercial education scheme, the council have found that one of the most useful inducements they could offer to schoolmasters, parents, and youths has been that afforded by the list of firms who, in filling vacancies in their offices, have consented, "other things being equal," to give a preference to holders of commercial education certificates. The existence of such a list (which at present comprises out of a membership of over 3,600, about 200 names) is found to be of great use to schoolmasters in inducing parents to allow their sons to be educated on the lines of the Chamber's scheme, in view of the likelihood of employment it holds out.

Electric Traction in Germany.—It is proposed to construct an electric tramway between Bullay and Prarbach.—Authority has been received for the construction by the local accumulator company of an electric tramway between Hagen and Eckesey. The accumulators of the company are, of course, to be used on the cars. Work is to be begun at once, so that the line may be ready by the summer. It is intended subsequently to build an electrical line from Kükelhausen to Haspe, which is to be completed this year. There is also a prospect of electrical lines being laid down to Schwelmer, Herdecker, and Dahler.—Work is to be commenced shortly at Munich in connection with the electric tramway from Färbergraben to the Isarthal railway station *vid* Sendlingerstrasse and Thalkirchnerstrasse. Provided no technical difficulties occur, the line should be opened by May.

Athens Exhibition.—Information has been received from the Foreign Office, through the Science and Art Department, respecting the industrial exhibition at Athens. Her Majesty's Consul at the Piræus reports that a permanent industrial exhibition has been organised by the Société Biotechnique at Athens, and will be officially opened on April 28 (April 16, O.S.). This exhibition, although intended only for native products, will be accessible to foreign exhibitors of such articles as may assist in the development of Greek industries. All expenses will have to be paid by the exhibitors, who will, moreover, have to pay a tax of two drachmas for each article worth 100 drachmas. Articles worth more will be charged half a drachma per hundred in addition. The committee of the exhibition undertakes to sell the exhibits at a commission of 5 per cent. The exhibition will be open each year from March 13 (March 1, O.S.) to July 12 (June 30, O.S.), and from September 27 (September 15, O.S.) to January 27 (January 15, O.S.).

Experiences of a Cable Steamer.—A Shanghai paper states that the Great Northern Telegraph steamer "Store Nordiske" met with very severe weather when on the way to Possiette Bay. The steamer was only about 50 miles from her destination when she encountered a strong northerly gale of typhoon force, accompanied by driving snow that prevented anything from being seen, and the cold was intense at the time, the thermometer indicating 40deg. of frost. Everything on deck was a mass of ice, and of course the steering gear was useless. In this helpless condition the steamer fell into the trough of the sea and was in danger of capsizing, and it was only by almost superhuman exertions that she could be kept going. When the gale moderated all hands were employed to clear the vessel of ice, it being estimated that there were 150 tons weight on board, and this arduous work occupied the crew two entire days. Photographs were taken of the "Store Nordiske" when the gale abated which gave an excellent view of the extraordinary circumstances in which she was placed.

New Mains.—At Tuesday's meeting of the London County Council the Highways Committee reported that they had considered a notice from the County of London and Brush Provincial Electric Lighting Company of intention to construct 42 transformer-chambers in the parishes of St. Luke and Clerkenwell. Nothing had occurred to diminish in any way the strong objection entertained by the Council to the space under the public thoroughfares being appropriated for the construction of transformer-chambers of large size; and the committee recommended that the Council formally disapprove the works. They had also considered a notice from the House-to-House Electric Supply Company of intention to lay mains in Marloes-road. These, which comprise both high and low tension mains, were approved of. Notices had been given by the Metropolitan Electric Supply Company of intention to lay mains in Charing Cross-road, Great Newport street, and Long-acre, on the north side of Dorset-street, in Cosmo-place, Little Ormond-street, and Queen's-square, south side. No objection was raised to the proposed works, but it was stated that the mains for Charing Cross-road should so far as practicable be laid in the subway there. A notice had been given by the Westminster Electric Supply Corporation of intention to lay mains in Davies-mews. The proposed works were approved of. A notice was received from the Vestry of Hampstead of intention to lay mains in High-

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road, Kilburn. The Vestry is the undertaker under the order, and the Council has no power of approval or disapproval of works.

Institution of Junior Engineers.—At the meeting of this institution held at the Westminster Palace Hotel last Friday (5th April), the chairman, Mr. H. J. Joung presiding, a paper on "The Study of Alloys" was read by Mr. Walter G. McMillan, lecturer on metallurgy in the Mason College, Birmingham. The author gave an account of some of the recent researches of Roberts-Austen, Wright, Heycock, and Neville, and many others on the nature and constitution of alloys. He showed how some pairs of metals formed homogeneous mixtures, which might be kept for hours in a fused condition unchanged, whilst others rapidly separated into layers, and he described the influence of increasing proportions of a third metal upon the immiscible pairs. It was then shown how mixtures, uniform when fused, might give a non-homogeneous metal when solidified, which was explained by referring to the tendency to form "eutectic" alloys of definite composition, with lower fusing points than those of the metals used, so that one constituent after another crystallised out from the mass of fluid metal, leaving at last the eutectic alloy to solidify in the spaces around the separated solid particles. In conclusion, the author urged the necessity for precision and system in reporting results, and regretted the use of trade names which (even if in certain cases justifiable) were misleading to the lay mind and tended to produce great confusion in the literature of the subject, because there was no certainty as to the meaning of an author who merely employed such a term without giving an analysis of the mixture. As knowledge advanced, engineers would require to know the composition of the alloys in the market that they might be able to discriminate for themselves their fitness for the required purpose.

Obituary.—The death took place on Sunday last of Mr. John Henry Greener, electrical engineer, at Herne Hill, in his sixty-sixth year. He was born at Etherley, Durham, in 1829, and began his career in London on the Blackwall Railway in 1843, and was there first connected with the electric telegraph. In 1847 he entered the service of the old Electric Telegraph Company. In 1853 he was appointed by the company to construct the first line of telegraph erected in Norway; and two years later he went to Denmark to construct the telegraphs on the Royal Danish railways. Shortly after his return, says the *Times*, he proceeded to Ireland to report upon the state of the lines between Dublin and Galway, for the purpose of establishing direct communication with the Atlantic cable. At the end of 1860 he was selected by the Secretary for India to report on the condition of the Turkish telegraph lines in Asia Minor connected with Constantinople; for the Red Sea cable had temporarily failed, and it was considered advisable that we should have alternative means of communication with India by telegraph. Mr. Greener was despatched to Bombay in 1862 to accompany an expedition for taking soundings and selecting landing-places for the proposed cable from Kurrachee to Fao, at the head of the Persian Gulf. Mr. Greener having constructed land lines from Bagdad to the latter place, and the cable having been successfully laid thence to Kurrachee, his work in the East terminated, when communication along this route between England and India was completed in 1864. On returning to England, he became inspecting engineer for stores to the India Office. He was also appointed in the same capacity as engineer for the Crown Agent for the Colonies and for the Agent-General for the Cape of Good Hope. He severed his connection with the India Office a few years ago, but kept his position at the Colonial Office until his death. Among members of his profession Mr. Greener was always regarded as one of the most able of practical telegraph engineers.

Kingdon's System of Laying Electric Mains.—Systems of electric mains in which the conductors, whether insulated or bare, are drawn into iron or other pipes or laid in conduits, are open to the objection that an empty space is left round the cables or conductors, where an explosive mixture of air and gas may accumulate. Armoured cables are not open to this objection, but as the armouring can be easily penetrated by a pick, additional protection is necessary. In the Kingdon system of laying electric mains these difficulties are overcome in a simple manner. The conductor, insulated with indiarubber, paper, or other material, is thoroughly protected against mechanical injury by an iron or steel channel of U-shaped section placed above the cable. The peculiar form of the exterior of the channel causes a pick or other tool to glance off to one side without penetrating the iron. The interior of the channel is of such shape as to approximately fit the cable. Below the cable is placed a strip of iron or wood, which is moulded to fit the cable. This is forced upwards within the channel, so that it is not liable to displacement or injury. Joints in the channel are covered by means of iron sleeves or slips, which serve also to secure the strip in place. For continuous currents a single-stranded cable may be employed. For alternating currents, two cables laid side-by-side, or a concentric cable, are used. Concentric or triple-concentric cables are also employed in the case of two or three wire continuous-current systems. Where branches from the mains are required cast-iron junction-boxes are inserted, which are filled with solid insulating material after the joints are made and insulated. Where a branch is not immediately but may subsequently be required, a short length of channel is placed, which can be easily removed by driving back the sleeves at either end for the substitution of a junction-box. Bends can easily be arranged for places where the cables have to pass round corners or to dip downwards so as to avoid obstruction. Mr. J. A. Kingdon, 29, Marlborough-hill, N.W., is the inventor of the system.

Lecture on Electric Traction.—At the Croydon County Polytechnic, on the 8th inst., Mr. C. H. Yeaman, A.Inst.E.E., delivered a lecture on "Electric Traction, with Special Reference to Traction on Common Roads." The lecturer opened his subject by a brief discussion of the reversibility of the dynamo machine. He then proceeded to describe the three types of electric traction systems—the conduit or underground, the trolley or side rail, and the accumulator or self-contained car. The different proposals which have been made from time to time on the subject of tramways were reviewed, and some reference was made to the application of electrical power to railways for long-distance and high-speed traction. The Heilmann locomotive and the Boynton bicycle car were instanced as being two developments along different lines, while many of the English, Continental, and American lines were incidentally dealt with. The details of electric traction work and the difficulties which have in the past beset it were also the subject of notice, but it was shown how electrolytic troubles were got over by rail bonding or electric welding, but powerful brakes were obtained by an adaptation of the principle of Foucault's disc, and how the fender question was tending in America. In the second portion of the discourse Mr. Yeaman drew special attention to accumulator cars running on rails, and also those adapted for ordinary roads. The leading features of accumulators of different types were gone into, samples being before the

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audience, and then the use which had so far been made of the storage system was illustrated by references to the Birmingham and other tramways. The common road vehicles of Garrard, Cummings, Arnold, Radcliffe Ward, Bersey, and others were illustrated, and their peculiarities dwelt upon. The lecturer regarded the future of self-contained vehicles as being a promising one, and brought his discourse to a close by a short consideration of the sanitary and commercial aspects of the problem. The lecture was copiously illustrated by experiments and lantern projection, and was received with great appreciation by a large audience.

Code Cablegrams.—On Monday, in the House of Commons, Mr. Henniker Heaton asked the Postmaster-General whether he had observed that the new official vocabulary for code cablegrams, prepared by the International Telegraph Office at Berne, was objected to on the grounds, among others, that it contained words identical in signals with other words, words with only one signal difference from other words, words with only one letter difference from other words, words with first letter's signals dangerously like others, and words representing names of articles of commerce, coins, numerals, and firms, and localities; and whether this vocabulary could still be amended and extended, or whether it was binding as it stood on the public; and, if amendments would be accepted, whether he would suggest that the official compilers of it should consult with two or more British telegraph experts and with the Associated Chambers of Commerce with a view to removing the defects complained of. Mr. A. Morley stated that he was aware that objections had been raised on the grounds mentioned, but he might remind the House that the new vocabulary did not come into force until January 1, 1898. There was ample time for consideration in the interval, and the matter was receiving careful attention. Being questioned by a Liverpool correspondent in regard to the prospective compulsory telegraph code for all European telegraph offices, Mr. J. Henniker Heaton, M.P., wrote: "In the *Times* of the 16th ult. you will find the Postmaster-General's answer to a question of mine on this subject, his view being that our hands are tied by our connection with the Postal Union. This is only another proof of the recklessness with which the interests of British trade are signed away by our amateur diplomatists at the Post Office. The cables are in British hands; the bulk of the world's trade in which cabling is required is in British hands; yet British merchants are not consulted in the matter. It is well known that a code cannot be too extensive, since the larger the number of words the greater is the choice of expressions denoted by them. Accordingly, hitherto merchants have been allowed to take words from eight appointed languages, and many of them have been at enormous expense to prepare codes from these languages embodying upwards of half a million words. Now, the official vocabulary only includes between 200,000 and 300,000 words, so that the range of expression is greatly restricted, while the money spent on private codes is henceforth a great loss. I say nothing of the objections to the official list arising from the use of similar pairs of words, the want of an index, etc. My contention is that, if there is to be an official list, it should include all suitable words in the eight authorised languages, or that, in the alternative, private codes drawn from these languages should be admitted. Anything less would amount to a serious diminution of the utility of cables, and a corresponding injury to British trade. In my opinion, a deputation should wait on the Postmaster-General to remonstrate against the imposition of the official list; above all, for extra-European cablegrams."

The Falls of Foyers.—We have previously announced that a scheme is on foot for the utilisation of the Falls of Foyers, in Inverness-shire, in connection with an electric transmission plant to be used for the production of aluminium. This proposal has just caused a somewhat violent article in the *Daily Chronicle*, which on Monday, under the heading of "The Vandal in Scotland," came out with the following: "Are the Falls of Foyers to be swept off the face of the earth? This is the question which in another form came up before the Inverness District Committee on March 8, and which they wisely remitted to the County Council. As Sir George Trevelyan casts the responsibility on the same body, the county councillors of Inverness-shire must look to their laurels. The Fall of Foyers is undoubtedly the finest waterfall in the British Isles, and many who have wandered far in other lands still revert to it as of surpassing beauty. We will not attempt to rival the many poets who have described these falls; nor can the painter or photographer do justice to their picturesqueness. For their distinctive feature, the masses of spray in which on sunny days a complete circle of rainbow can be seen, eludes alike the brush and the camera. To be known, therefore, they must be seen; yet, if certain persons have their way, they will never be seen more. A body, calling itself the British Aluminium Company, has arranged to purchase the estate of Foyers, on which the falls are situated, and proposes to use the water power to produce electricity, and thereby to extract aluminium from clay. For this purpose it plans to deflect the River Foyers from its present channel, and lead water in an 8ft. pipe to the shores of Loch Ness. Now, by a slight additional expenditure they might get their water power without damaging the falls, but will they do so? The plans of the company involve the turning aside of two roads in Strathherrick, and for this they require the sanction of the County Council. The agents of the company have been lavish in their promises of remunerative employment and improved trade—indeed, they hold out the prospect generally of a golden age in the near future if the inhabitants will but banish their consideration for lovely scenery, and permit prosaic business men to work their money-making schemes. Probably an appeal to the æsthetic feelings of the district committee might have been quite in vain had not the chairman tactfully pointed out that the financial state of the company has been subjected to public criticism. The company is accordingly to lay its plans before the County Council at its next meeting, and that body has in its power—(1) to stop the company completely; (2) to leave it an entirely free hand; or (3) to exact from it substantial guarantees that its operations shall not injure the natural beauty of the country. In the interests of a perfectly impartial consideration of the matter, it is perhaps unfortunate that most of the officials of the County Council are financially interested in the company; that one of the chief Inverness journals is the property of its local agent; and that, whereas the company are carrying on an active canvass, we hear of no organisation on the other side. The danger therefore is felt to be that the wider question of preserving a piece of beautiful scenery which is of national importance may be sunk in the smaller one of an accidental commercial undertaking which chooses to find the waters suitable for its private concerns—a very real danger, seeing the decision lies with a local body, probably biassed, with which local interests must be supreme. It is, moreover, by the merest chance that any public body has anything to say in the matter, though if law were, as we are sometimes told it is, the expression of use and custom, the Falls of Foyers belong to the public."

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THE THEORY OF ALTERNATING CURRENTS.—III.

BY A.INST.E.E.

§ 7. **Simple Ideal Alternator.**—An alternating current is one which periodically varies in magnitude and direction, fluctuating alternately in positive and negative directions at a rapid rate, thus forming a succession of undulating waves. Such a current is set up by a rapidly alternating E.M.F., and to understand these currents we must investigate the nature of alternating E.M.F.'s, and to simplify matters we shall neglect any inductance which may be present in the circuit. Our starting point is Faraday's discovery made in 1831—*i.e.*, that an E.M.F. is set up in any part of a conductor, whenever such portion cuts lines of force, so that the number of lines of force looped with the conductor increases or decreases.

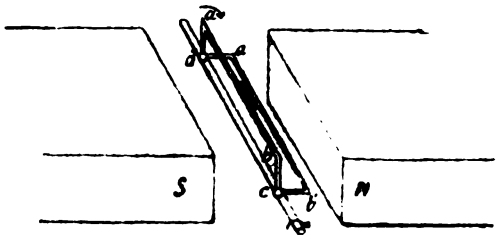

FIG. 3.

To take a particular case, let us consider a single rectangular coil of wire placed in a uniform magnetic field, and capable of rotation about one of the long sides as an axis, which is horizontal and perpendicular to the direction of the lines of force, as shown in Fig. 3, which are horizontal. It is evident that when the plane of the coil is vertical—*i.e.*, perpendicular to the lines of force, as at *a*, *b*, *c*, *d*—it is enclosing the maximum number of lines of force. By moving it through 90deg. to the position a^1, b^1, *c*, *d* the plane of the coil is now parallel to the lines of force, and the coil encloses the minimum number of lines, which is zero. In other words, the rotation through 90deg. is equivalent to emptying the coil of lines, to do which the coil has cut the maximum number of lines of force. By rotating the coil through the next quadrant the plane of the coil is again vertical, and it again encloses the maximum number of lines—that is, the movement through the second quadrant is equivalent to filling the coil with lines of force from the opposite side. The result of this cutting the lines of force is to make the side *a b* of the coil the seat of an E.M.F., the direction of which is the same during the motion through the two quadrants. On continuing the rotation of the coil, it is again emptied and filled as before, and the direction of the resulting E.M.F. is reversed. This is the simple physical aspect of the problem, and we must now consider the magnitude of the E.M.F. induced, which is proportional to the rate at which the magnetic flux is cut. As we shall see presently, the E.M.F. varies harmonically, and for this reason we shall now explain the elementary principles of harmonic motion.

§ 8. **Simple Harmonic Motion.**—When a point, P, describes a circle with uniform velocity, the point *p*—the foot of the perpendicular from P on a diameter, as $A\,O\,A_1$ in Fig. 4—will have a to-and-fro motion along $A\,O\,A_1$, the velocity of which will be variable. The motion of *p* is typical of a certain kind of motion of frequent occurrence in physical phenomena, and which, in fact, lies at the root of all wave movements. Technically, it is known as *simple harmonic motion*, and it is important that we should be able to determine the velocity of *p* relatively to that of P. Let V be the velocity of P, which we know to be uniform Now, circular motion may be produced by two simple harmonic motions in directions at right angles to one another; in other words, two simple harmonic motions taking place simultaneously along $A\,O\,A_1$ and $B\,O\,B_1$ will produce circular motion equivalent to that of P. Then by obtaining the component of the motion of P along $A\,O\,A_1$, we shall obtain the actual motion of *p*. If the velocity of P be assumed to retain the direction it has for the instant it is at P—that is, along P Q, which is the tangent to the circle at P—then by denoting the value of V by the length P Q, the resolved portion in the direction $A\,O\,A_1$ will be denoted by the length $P\,p_1$ to the same scale as P Q is drawn. Now, from the geometry of the figure it is obvious that the angle $P\,Q\,p_1$ is equal to θ, and $\sin\theta = \frac{P\,p_1}{P\,Q} = \frac{P\,p_1}{V}$; that is, $P\,p_1 = V \sin\theta$, and this is the velocity of *p* in the direction $A\,O\,A_1$, in terms of the velocity, *v*, of P and its position. Since the velocity is proportional to the *sine* of the angle subtended by the arc described by P, we see that the velocity of *p* varies for every position of P—that is, the velocity of *p* is not uniform. Now, the value of sin 0deg. and sin 180deg. is zero, consequently

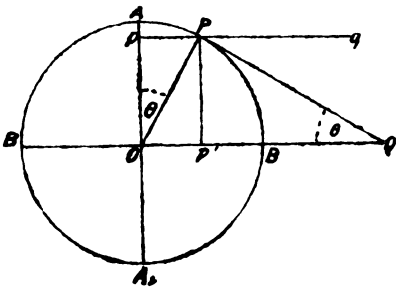

FIG. 4.

the velocity of *p* is zero at A and A_1; but the value of sin 90deg. is unity, therefore the velocity of *p* at O is equal to the velocity of P, and this is its maximum value. In other words, *p* begins to move slowly at A, increases to its maximum at O, and decreases at the same rate until it reaches A_1, where its velocity is zero. Immediately afterwards *p* moves backwards along the same diameter, and calling the motion from A to A_1 positive, the motion from A_1 to A will be negative, from which we see that the direction of motion of *p* is reversed twice every revolution of P.

The results thus deduced may be conveniently represented graphically. We have seen that the velocity of *p* is V sin θ, and if the radius of the circle be taken to denote the value of V, the velocity of *p* at $p = O\,P \sin\theta = O\,P \times \frac{P\,p}{O\,P} = P\,p$, since $\sin\theta = \frac{P\,p}{O\,P}$. Therefore, for every position of P the velocity of *p* is represented by the length of the perpendicular from P on $A\,O\,A_1$. In Fig. 5, the circumference of the circle is divided into a number of equal parts, and perpendiculars let fall from each on $A\,O\,A_1$. In our case we have taken 24 parts, but only those in the upper half are shown in the figure. Any number of parts, however, may be taken, but it is advisable that the points A, B, A_1, and B_1 coincide with four of the divisions. Since the velocity of P is uniform, the time taken by *p* to move from A to p_1, p_1 to p_2, etc., will be the same, and the lengths of the divisions along $A\,O\,A_1$ indicate how the velocity of *p* varies, whilst the lengths of the perpendiculars, $P_1\,p_1$, $P_2\,p_2$, etc., denote the velocity of *p* for the different positions of P—*i.e.*, P_1, P_2, etc.—showing at a glance how the velocity of *p* increases until O is reached, and then decreases.

§ 9. **Sine Curves.**—The graphical representation given in Fig. 5 may very conveniently be extended so as to show at a glance the undulating character of the velocity of *p*. The method adopted is very simple, and we shall very frequently make use of the resulting curve, which is constructed as follows: The left-hand portion of Fig. 6 consists of the last figure reproduced, with the diameter $A\,O\,A_1$ produced indefinitely to the right. This line serves the purposes of a zero line, and is divided into a number of equal parts, A p_1, p_1, p_2, etc., to represent equal intervals of time. From each of the divisions, p_1, p_2, p_3, etc., perpendiculars are erected equal in length to $P_1\,p_1$, $P_2\,p_2$, etc., taken from the figure on the left; consequently each of these perpendiculars represents the sine of the angle through which P has moved in the time corresponding to the interval of time denoted by p_1, p_2, etc. For instance, the perpendicular $P_2\,p_2$ measures sin θ, θ being the angle moved through by P in the time denoted by p_2. The

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method of projecting the perpendiculars as shown by the dotted horizontal lines is the most convenient method of getting the points P_1, P_2, P_3, etc.

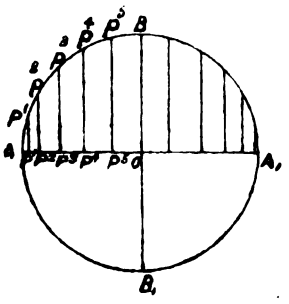

FIG. 5

By drawing the curve through A, P_1, P_2 . . . to A_1 and continuing it to A below A O A_1, we get a *true sine* or *sinusoidal curve*, which expresses graphically the fact that the successive values of the heights of consecutive points on the curve from the zero line vary as the sine of the angle through which the point P has moved. Such a curve can always be constructed when a quantity varies according to a simple harmonic law. The shape of a sine curve depends upon two quantities, which are analogous to the velocity of P and the radius of the circle, or, in other words, to the two components of wave motion.

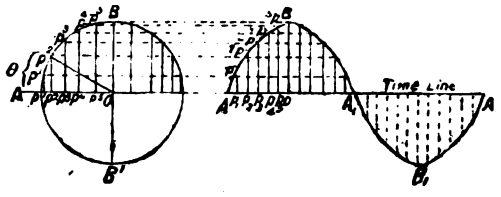

FIG. 6.

§ 10. **Alternating E.M.F.'s.**—The student will now be in a position to see that the motion of P corresponds to the motion of the side *a b* of the rectangle, *a*, *b*, *c*, *d*, shown in Fig. 3 above, especially if he imagines himself to be taking an end view of the rectangle rotating in the magnetic field between N and S. In fact, the circle in Fig. 4 is the path traversed by the corner *b* of the rectangle, whilst P, B, A_1, and B_1 are positions taken up by *b* during one revolution. Now, to get the value of the E.M.F. induced, we must determine the rate at which *a b* cuts the lines of force of the field. To do this we denote the depth of the field by the length, A O, and the breadth by the length, *a b*, of the rectangle; and as the length *a b* is constant, it is obvious that the number of lines of force enclosed by the rectangle in any position whilst rotating is proportional to the length *p* O, which, as we have seen, varies for every position of *b*—in other words, the lines enclosed is proportional to cos θ. But the rate at which the lines are cut is analogous to the velocity of the point *p*, which, as we have seen, is proportional to sin θ, where θ is the angle moved through by the rectangle from the vertical position.

Then if H = the number of lines of force per square centimetre, and A = the area of the rectangle, *a*, *b*, *c*, *d*, in square centimetres, the total number of lines enclosed by the rectangle when in the vertical position = H × A; and from what has been said previously, it is clear that the number cut whilst the rectangle moves through the angle θ is H . A sin θ, and this is a measure of the E.M.F. induced at the instant the rectangle makes an angle θ with the vertical. Let N = H × A, then $E_\theta = N \sin \theta$ (absolute units).

A more general way of expressing the instantaneous E.M.F. is to state θ in terms of the unit of angular velocity. As is well known, the radian, the unit of angular velocity, is the angle subtended by an arc equal to the radius. Since the circumference of a circle = $2\pi r$, it is evident that one revolution is equivalent to describing an angle of 2π radians. The symbol ω usually denotes the number of radians described in unit time. Therefore, if T be the time occupied in one revolution, and *t* the time taken to describe the angle θ, it is obvious that

$$\theta = \omega t = 2\pi \frac{t}{T}.$$

In an alternator, however, the speed is usually such that it makes *n* revolutions per second, and if the coil consists of S turns, then the value of the E.M.F. induced expressed in volts after a short time, *t*, has elapsed since the coil left the vertical position, will be

$$E_1 = \frac{2\pi}{T} S N \sin \frac{2\pi t}{T} \div 10^8 \quad . \quad . \quad . \quad (1)$$

since one volt = 10^8 absolute units; but $\frac{1}{T} = n$, therefore (1) may be expressed as follows:

$$E_1 = 2\pi n S N \sin 2\pi n t \div 10^8 \quad . \quad . \quad . \quad (2)$$

or, $$E_1 = D \sin 2\pi n t,$$

where $D = 2\pi n S N \div 10^8$.

ELECTRIC MAINS IN PARIS.

BY A. MONMERQUE.

(Continued from page 393.)

There was in use in another section of Paris a system of mains now condemned by experience—*i.e.*, the system of iron hooks for supporting insulated cables. In this section the mains were indiarubber covered, laid in cement concrete culverts, being supported on iron hooks built into them, as shown in Fig. 8. These iron supports were enamelled, and it was hoped to prevent them rusting by this process. It did not do so, and in a short time the iron was rusted everywhere. The rust of itself did not matter, but its action on the insulation became serious in reducing the insulation resistance of the cable.

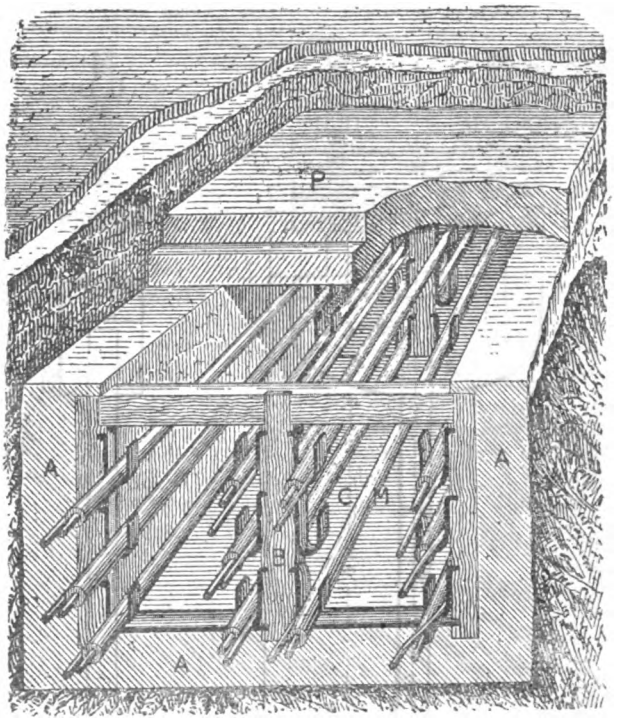

FIG. 8.

The specification of the cables was as follows: A tinned copper conductor, covered with one coating of pure rubber, one of an indiarubber mixture 2mm. thick, and two of rubber tape, the whole vulcanised and braided, and then dipped in bitumen. After laying, the insulation resistance of these cables was very satisfactory, but after a year's work the insulation resistance of the individual sections of the mains tried singly did not average more than 2,000 ohms per section, the maximum voltage of distribution being 220 volts. The minimum insulation resistance per section

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allowed by the rules issued by the municipal authorities on September 15, 1893, was 242,000 ohms.

In the extensions of the network the engineers immediately abandoned this system in favour of armoured cables of the same type as used in the section of the Place Clichy. Little by little the faults got worse, till it was decided to condemn the iron hooks. After having clearly proved the inherent faults of the enamelled iron as supports for the cables, the engineers tried several palliatives, such as putting a rubber shield between the iron and the cable as a protection. It was finally found necessary to replace the hooks with another system of support. This radical decision was come to in order to avoid as much as possible the continued opening out of the trenches under the public footpath.

It was necessary to adopt a tried system which did not necessitate the opening of the conduits for purposes of supervision. With this idea they simply used insulators similar to those adopted when the cables are bare. So an insulator was employed of the type shown in Figs. 9 and 10.

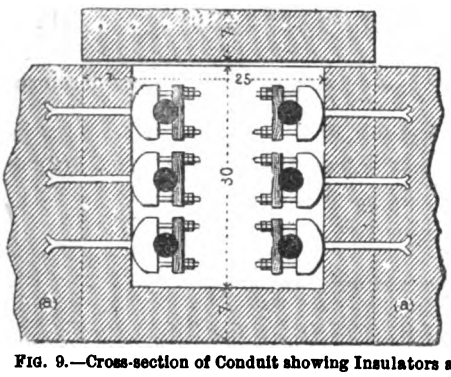


FIG. 9.—Cross-section of Conduit showing Insulators and Insulated Cables.

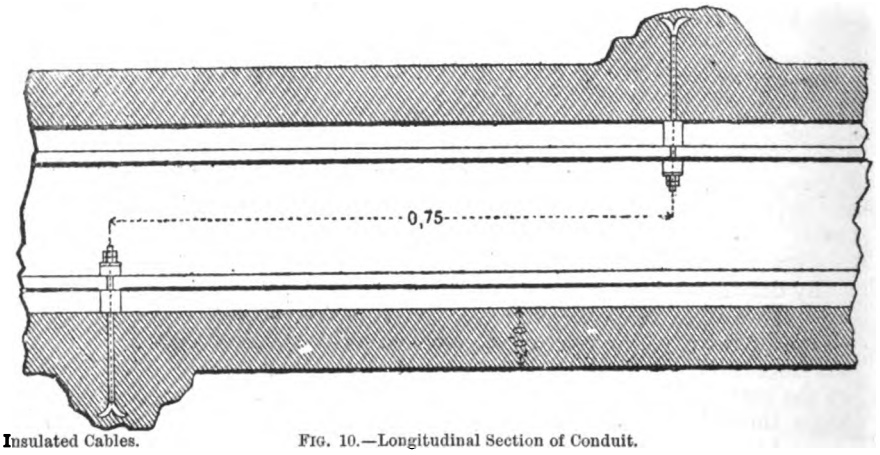
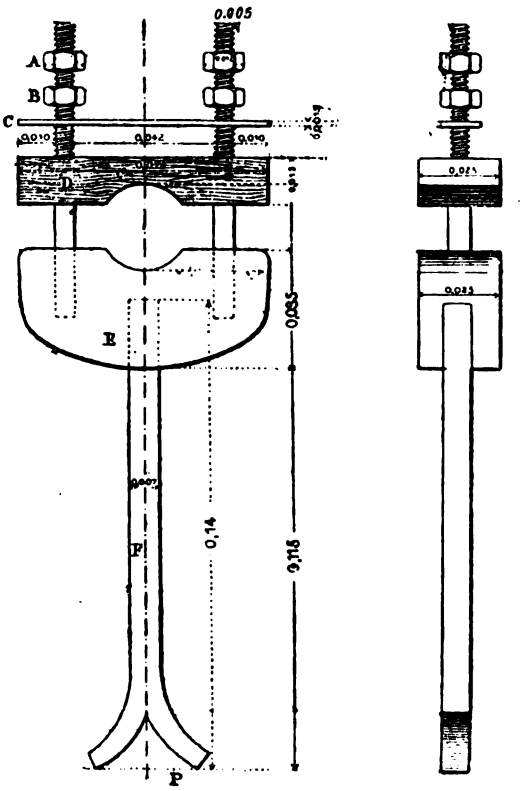


FIG. 10.—Longitudinal Section of Conduit.



FIGS. 11 AND 12.—Details of Insulators.

The insulators were mounted on iron stems 6in. long, being sealed in with sulphur, and the other end cemented in to the sides of the conduits. These sides were originally only $2\frac{3}{4}$in. thick, and had to be increased, as shown by the dotted lines, to double this thickness, to give the necessary support. Figs. 11 and 12 show the details of the insulator. The part E is made of smooth porcelain with rounded grooves to hold the cables. In this porcelain two iron screws are cemented, by means of which cross-pieces of wood, D, clamp the cable in place. The insulators cost $5\frac{1}{4}$d. each. When a type of conduit as illustrated is used having a breadth of 10in., and containing one feeder and one set of distributing mains on the three-wire system, the insulators are placed 2ft. 6in. apart on opposite sides, so that the cables are supported every 5ft. The actual cost per yard of the transformation was as follows:

	s.	d.
Labour, etc.	3	$7\frac{1}{2}$
Cement, etc.	1	10
Insulators	1	10
Sundry items	0	$8\frac{3}{4}$
	8	$0\frac{1}{4}$

In these charges the cost of breaking up the streets and of repairing them is not included.

It will be seen that the cost is small compared with the great inconvenience of repeatedly opening out the conduit, or at least of abandoning the conductors and relaying an entirely new network, which would have been necessary had not this method of overcoming the difficulty been adopted. We are able now to give the results obtained with this system compared with those obtained when the iron hooks were employed. The insulation resistance of the network was taken in sections every Monday. The conductors were so arranged as to be readily uncoupled for testing a three-wire system, being used at 220 volts. The supply was thus only interrupted during the short time the test was being made. When testing a feeder, the network was supplied for the time being by the other feeders. The tests were taken with a small ohmmeter, with a hand-driven generator, at about 200 volts. The ohmmeter indicated up to five megohms; above that value the exact insulation resistances did not matter.

The results found are tabulated below in a form which shows clearly the improvement effected by the suppression of the iron hook supports. The figures show that the insulation resistance was improved by the new insulators to about 250 times its original value for the negative wire, 18 times for the zero wire, and 16 times for the positive wire. The insulation of all three wires is above 242,000 ohms, which is the minimum allowed by the regulation for this section. It is to be remarked that the insulation resistance of the negative wire is always less than that of the positive. This seems to be an invariable rule whatever the nature of the network.

Date.		Sub-main. Length.	Insulation to earth. Ohms.	Insulation to earth. Per mile.	Remarks.
May 19	−	66 yards	2,000	75	With iron hooks.
	0		60,000	2,260	
	+		300,000	11,300	
June 12	−	66 yards	500,000	18,800	With insulators.
	0		1,100,000	41,200	
	+		5,000,000	188,000	

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After having indicated the system of mains which experience has condemned in Paris, it will be interesting to review the divers systems in use and now being laid in the different sections, and we shall proceed to discuss each system separately.

(To be continued.)

THE CAIL-HELMER SINGLE-BEARING DYNAMOS.

We are able this week to further supplement the information we gave in our last issue about this interesting type of dynamo.

The accompanying table is sufficient to enable all makers of dynamos to compare their designs with those used by the Cail Company in Paris. It will also give useful information as to the efficiency allowed by the French engineers and accepted by the general public.

LIST OF DETAILS OF CAIL-HELMER DYNAMOS.

Number of design	H_4.	H_5.	H_6.	H_7.	H_8.	H_9.
Useful power, in kilowatts	1·55	2·5	3·8	5	7·6	10
Difference of potential, in volts	115	115	115	115	115	115
Current, in amperes	13·5	22	33	44	66	87
Speed, revolutions per minute	1,550	1,500	1,420	1,330	1,170	1,000
Circumferential speed, feet per minute	3,570	3,640	3,670	3,820	3,830	3,840
Armature core, outside diameter, in inches	8 8	9·3	9 9	11	12·5	14·6
Depth of core, in inches	·95	1·11	1·2	1·35	1·53	1·9
Length, in inches	1·6	2·05	2·4	3	3·65	4·5
Number of active wires	1,944	1,200	1,104	743	642	626
Current density in amperes, per square inch	3,660	3,550	3,350	3,220	2,900	2,580
Flux in C.G.S. lines	257,000	421,000	480,000	790,000	990,000	1,183,000
Loss in copper resistance in armature, watts	199	254	341	430	607	753
,, ,, in magnets, watts	61	78	104	132	186	213
Hysteresis, Foucault, and mechanical losses, watts	400	511	687	865	1,225	1,517
Total losses, watts	660	843	1,132	1,427	2,016	2,483
Electrical efficiency, per cent.	85·7	88·5	89·7	90	90·5	91·2
Commercial efficiency, per cent.	70 2	75·2	77·1	78·1	79	80·2

We would remark that such a full list of essential details has never been published by any English firm of electrical engineers.

SOME METHODS OF COLLECTING THE ENERGY IN ELECTRIC RAILWAYS AND TRAMWAYS.*

BY M. HOLROYD SMITH, MEMBER.

The first principles governing the use of electricity as the motive power for tramways and railways are now so well understood that no reference need be made thereto, except so far as occasion requires in dealing with the subject under consideration. The success or failure of an enterprise often depends upon an apparently insignificant detail. The subject-matter of this paper is an example. Perhaps few approaching it for the first time would realise its importance until they come face to face with the difficulties involved. Conditions pertaining to the collector may be summarised as follows: (1) provision for making and maintaining contact between the motor on the car and the supply conductors, whether that be overhead or underground; (2) the avoidance of damage, either electrical or mechanical, should the collector become blocked or the car leave the track; (3) the collector must be able to take the points at turn-outs, and traverse crossings without fouling them or short-circuiting; (4) the collectors must be so insulated as to be safe to handle, and avoid leakage; (5) no danger or damage to the public must result from their use; (6) they must be simple and durable, and the working parts must be cheap to renew.

Perhaps the most interesting way of treating this subject would be chronologically, tracing its developments, and that shall be done as far as possible whilst classifying the different types. In the time available it will be impossible to enumerate all that has been done; the selection made must therefore be regarded as typical. In the first example of electric traction without carrying a battery on the car, made by Thomas Hall, of Boston, U.S.A., in 1852, where the supply current was taken by one rail and returned by the other, and in the subsequent examples on a larger scale by Dr. Siemens in 1879, and afterwards by Volk, in Brighton, the wheels, of course, had to be insulated one from the other or else they would "short-circuit" through the axles, and they obviously formed a simple and ready means of collecting the current; but considerable difficulty arose in gathering the current from the wheels owing to the unavoidable collection of dirt. It is no use entering into any details of the brushes, discs, clamps, etc., tried, because the "go-rail come-rail" system of working tramways is not likely ever to be of practical utility. This was soon discovered, though slowly admitted, and the centre rail or conductor bar came into use. The early designer evidently had dynamo brushes in his mind, but difficulties arose in reversing the car—the brushes, which would stroke the bar easily when running one way, would double up if it were attempted to run them the other, and any surging or springing of the car would cause disarrangement. Another method was to use sliding shoes made of cast iron, and held together by the spring bolts, which are easily attached and removed, and accommodate themselves to any inequality of the bar, and, together with flexible pulling cords, permit the slider to travel as easily in one direction as the other. Both these plans require special arrangement of the conductor bar at points and crossings. The simplest form is that adopted in the City and South London line and elsewhere, where cast-iron curved flappers rest by their weight upon the conductor bar. As these still continue to be used, they must be found to act reasonably well, but it is obvious that should a fault or obstruction occur in the conductor bar (say, where it is replaced by wood at rail crossings), and the leading flapper fall, it would at once jam and cause a smash. It is a matter of surprise that a safer method has not been devised. Another example of collecting from a plain bar is that employed on the Portrush and Bushmills line. The conductor there is a T-iron forming a railing about 2ft. high on one side of the road; an arm projecting from the side of the car has a carriage spring at the end; on the underside of the spring is a shoe, which slides upon the rail. This works fairly well, but the inevitable dithering action of the shoe is objectionable. All these collectors slide on the bar, and it is natural to ask, Does not considerable wear and tear result, and could it not be avoided by rolling contact? Before discussing the relative merits of the two methods it will be well to give further examples.

The first underground electric channel—viz., that laid in the grounds of Moorfield, Halifax, in 1883—ran on four wheels, one side being insulated from the other, because one side collects and the other returns the current. In addition to the wheels, sliding shoes were provided. These shoes are free to rise and fall. This worked sufficiently well for experimental purposes, but was not considered good enough for work on a large scale, hence more elaborate designs were got out. First, a steel plate or plough is provided to pass upward through the channel slot to

* Paper read before the Northern Society of Electrical Engineers, April 8, 1895.

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the road surface, and the copper conductors are insulated and embedded in this plate. Instead of the sliders collector discs are used, and these are set at an angle with the line of movement, the consequence being that a combined rolling and sliding action was secured. A collector on this principle was used on the first electric locomotive tried on the Manhattan Elevated Railway, New York. The device may be accepted as the simplest way of making roller collectors useful, but experience shows that their use is to be avoided, because a roller gives very little surface contact for gathering the large current necessary for traction work. The wheels roll over any dirt that may be on the conductor bar, thus breaking contact and "sparking," and this excessive sparking causes more wear than the friction of sliding. The bearings of the rolling wheel are also a source of difficulty and trouble. The complications, the first outlay, the trouble and expense of maintenance, the cost of renewals, all tend to relegate roller collectors (with some exceptions) into the category of interesting relics of the past.

So far we have been dealing with collectors gathering the current from plain surfaces. The subject becomes more involved with conductors of varying forms, and classification is difficult. It is interesting to note that though in some cases too little care has been bestowed on the collector, in other cases unnecessary complication has been introduced. An example of the latter will be found in Count Du Moncel's treatise on "Electricity as a Motive Power," published in 1883, wherein he describes the electric tramway installed by the Siemens firm during the preceding electrical exhibition, and run between the Palais de L'Industrie and the Place de la Concorde, Paris. It is thus described: "The conductors were formed of two copper tubes slit lengthways, and laid along a small piece of wood suspended horizontally to posts erected along the road. The movable rubber or jockey to connect the rubber with these tubes required very delicate adjustment. The contact was made by a metal cylinder placed in the tube, one end of which was connected to the other across the longitudinal slit. A roller wheel worked on the tube, and was pressed against it by springs, so that the contact took place both at the piece sliding in the tube and the wheel rolling on the outside. This was amply sufficient. Each of the two conductors had a runner of this description, which was attached to the tramcar by insulated wires. The current was brought by one and returned by the other." This collector, though interesting, was too cumbersome and complicated to be repeated. There is outcry enough now about depriving the sensitive citizens of the blue vault of heaven by stretching single wires along the street. What would they say to two tubes and a wooden plank? The complication was also unnecessary, for without tracing the various devices of expanding shuttles running within the slotted tube it may be stated that the simple arrangement answers quite well enough for practical purposes. Two shuttles were used so as to secure plenty of gathering surface, and they were connected together by hard brass strip. This enabled the collector to wriggle freely through points. A collector similar in operation to this was designed and tested for use upon the Metropolitan Railway, London, where the conductors are angle irons supported overhead by an insulated stirrup. The collector can in this instance at any time be lifted off the angle irons, which, as regards points and crossings, can be treated the same as the rails. The whole arrangement lends itself admirably to railway work, and is in all respects preferable to the mid-rail bar system.

In some of the earlier electric tram lines, constructed in America and elsewhere, two overhead wires were used, one for the lead and the other for the return conductors; and on these wires ran little trolleys or carriages, similar to the collectors used at Moorfield, Halifax, turned upside down, with the arms dependent, and with the wheels grooved instead of plain. Considerable difficulty was experienced in keeping the trolleys on the wires, partly because it was found impossible to fix and maintain the wires always in the same horizontal plane (especially on curves); one would sag more than the other, causing the trolley to tilt; and partly because the designs used did not provide sufficiently for the pull and side strain of the hauling cord. The most recent example of this class of collector is working in the tunnel now being constructed at Blackwall under the Thames, where special provision has been made to overcome the difficulties referred to. In all collectors that slide on or in the conductors, and that are pulled forward by a cord or other flexible connection, provision must be made against accident in the event of the trolley or shuttle becoming blocked. This has led to many releasing clips being designed. They in themselves form an interesting study, but it would occupy too much time to attempt anything like a description of them here.

Reference has already been made to the trolley collector used in the first experimental conduit, and its unfitness for regular work has also been explained. It will be difficult to give a sufficient reason for the design of the various collectors used in underground channels without a brief description of the channels themselves; and as this society has its home in Manchester, it may be well to commence with the one constructed in a field at Cornbrook in 1884, and compare it with the one now at Budapest. Their differences are more questions of proportions than anything else. The conductors in the Manchester channel are semi-circular, and in the Budapest angular. In both cases the collector must have some expanding arrangement in order to keep the rollers or shoes in contact with the half tubes or angle iron. The rollers were fluted spirally with the intent that they should twist when drawn forward, and so clear the half tubes of any dirt or dust that might accumulate. The Budapest arrangement differs only from designs made at the time when the Manchester line was constructed in that the shoes there were square, having to work in channel instead of angle iron. The Blackpool channel, as originally constructed, has been recently altered as follows: the two C-shaped conductors have been removed and replaced by one solid copper rod. This has necessitated a modification in the collector. It consists of three main parts, one centre-piece, and two clearing ploughs for enabling it to run in either direction. One of the elements of success is the employment of flexible collectors flexibly connected to the car, and automatically detachable therefrom. For this purpose the two ploughs are joined to the centre piece, either by tempered steel strips or hinged wrought-iron plates. The steel plates forming the ploughs are held by cast-iron cheeks placed at an angle, and extending downwards a little past the bottom of the steel troughs forming the surface of the channel. Their upper ends terminate in a hook or finger curved backwards. The hooks receive the "snap loop" of the hauling ropes, which are attached to the front and rear of the car. These snap links are strong enough for ordinary work, but should an absolute block occur they break and the collector is left behind, while the car by its momentum still travels forward, and the snap link of the trailing rope slips off the hook of the rear plough. If this were not so, the force required to break it would make the collector kick up and cause the contact making part of the centre-piece to short-circuit with the underside of the steel troughing. The centre-piece consists of a cast-iron clamp holding a plate of strong brass, which is thoroughly insulated and protected by hardened steel guards where it passes the channel slot. The bottom of the insulated plate is bared of insulating material, and has attached to it a flapper or wing, held outward by a spring, so as to maintain contact with the conductor rod. The current is taken from the collector by a short length of insulated wire, provided at either end with a clip, one end attached to a terminal under the car, the other to the upper end of the brass plate that passes through the iron clamps. In case of the collector breaking away these clips readily let go. Another form of collector that has been tried with good results is that in which the conductor rod is either suspended from the roof of the channel or rests upon insulators, and is picked up by a hook forming the gathering part of the passing collector.

As this paper treats only of things that have been or are in use, it would be somewhat premature to give any description of collectors designed and intended to be used in lines about to be constructed. Attempts to run electric tramcars in series by high-tension currents involve so much complication, difficulty, and disappointments that no useful

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purpose would be served by describing any of the experimental collectors employed. A good deal has been written, and something has been done, in order to introduce closed underground channels; but it would be futile to attempt a description of the collectors without giving a full and particular account of the conduits themselves, and the various devices, electrical, mechanical, and otherwise, that they contain. They would form an interesting subject for a separate paper. Although not for a moment questioning the superiority of underground channels to overhead wires where the traffic is sufficient to justify the outlay, still the facility with which the overhead system can be constructed and worked, and its comparative small cost, renders it a thing to be desired by all who wish success to electric traction; for there are many lines that, if so equipped, could be made to pay, though the traffic would not be enough to secure a dividend on the larger outlay of an underground channel.

Reference has already been made to some of the difficulties pertaining to the use of trolleys or shuttles, or anything running on or in the overhead conductor. The trouble of fixing and removing, the constant risk of coming off, the strain put upon the conductor by the weight of the collector, and by the pull, necessitating the use of stays or poles very near together, all led to some better way being desired. One of the earlier examples of underneath contact is that employed by Dr. Hopkinson on the Bessbrook and Newry line, where a cross-bar supported on two upright poles, one on each side of the car roof, engages with the sag of drooping wires suspended over the track. This is simple, but not elegant. It requires two wires instead of one, it is difficult to adjust on undulating ground, and gives uncertain contact, the pressure on the cross-bar varying with the position the car occupies relative to the droop of the wire. A remedy for this was so self-evident that it is difficult to say who first thought of using only one wire stretched as taut as possible, and making contact by a movable cross-bar instead of a rigid one, for it must be admitted that those whose opportunities and position enable them to put a thing into practice are not always the first to conceive the idea. An advantage of this plan is the freedom for lateral movement. It facilitates the erection of the overhead wires on curves and at passing places. The chief weakness of the arrangement is the small point of contact between the round overhead wire and the round collector bar at right angles with it. Experiments have been tried with long rollers instead of the bar, and with curved plates free to rock, but none of them have proved really satisfactory. Of course the collector bars can be multiplied, but this adds to the unsightliness, and perhaps may account for the name "sky-scrapers" sometimes applied to them.

A similar but better arrangement is the "fishing rod," or, as it is more generally called, the "trolley bar," now largely used in America, where it originated, and to which the rapid advance in electric traction is largely due; and perhaps no one detail of equipment has had more thought and inventiveness bestowed upon it, for simple as the idea of a pole with a wheel at the top may seem, an instrument to fulfil all that is required is not easy to design. (1) It must of course be safe, strong, and light; (2) it must maintain good contact with the overhead wire, no matter how the height of the wire above the car may vary, and that contact pressure must, as far as possible, be uniform; (3) it must be capable of considerable lateral deflection, else curves and points could not be traversed; (4) it must be able to run in either direction safely; (5) it must be easily removable from the wire, and as easily replaced.

The cars that prevail in the States have no roof seats, which simplifies matters. Some admirable solutions of the problem are illustrated in figures accompanying Mr. Blackwell's paper read before the Institution of Electrical Engineers, therefore detailed description need not be given. A design about to be adopted in Bristol embodies a device, common to the American trolley bars, for equalising the contact pressure upon the overhead wire—viz., the triangular link, a most ingenious device requiring a little analysis. It is assumed that the pin sliding within the curved slot has a cam action, but inasmuch as this curved slot is struck from the centre of the pin, and that the plate from the pin may be regarded and acts as a simple link, it is very doubtful if the cam curve comes into action at all unless the trolley bar is swung right over, when the pin coming to the end or the slot could go no further, the triangular plate would become rigid, and the length of the leverage would increase.

Referring again to the necessity of securing approximately uniform pressure of the contact-making pulley against the underside of the overhead wire, a method is described in vol. xxiii. of the *Journal* of the Institution of Electrical Engineers. It consists of a pedestal somewhat like the upright of a jib crane, and free to swivel; near to the top of this pedestal the base of the trolley bar is hinged, near to the base is hinged a shorter bar, carrying at its end a link coupled to a joint on the "fishing-rod," thus forming a parallelogram. From the pedestal, at a point more or less close to the joint of the trolley bar, is attached a spring (or nest of springs), the other end being attached at the pivot point of bar and link, the springs thus passing diagonally across the parallelogram. The tendency of the spring is to close the parallelogram and keep the trolley bar at its highest position. It follows that if the trolley bar is depressed the parallelogram is expanded and the springs stretched, the varying leverage obtained by the parallelogram compensating for the increased tension of the springs, thus securing as nearly as possible a uniformity of pressure on the pulley end of the trolley bar through a wide range of movement.

It is impossible in one short paper to treat this subject exhaustively, and it is hoped that the omission of many other important and interesting devices may be credited to want of time and space, and not want of will.

SHORT-SERIES ARC LAMPS.

Messrs. Johnson and Phillips, 14, Union-court, E.C., have brought out a new short-series arc lamp (Brockie-Pell patent), two of which we illustrate herewith. That shown in Fig. 1 is for 7 to 30 amperes and for from 16 to 20 hours, while that illustrated in Fig. 2 is for 3 to 15 amperes and for 10 to 14 hours.

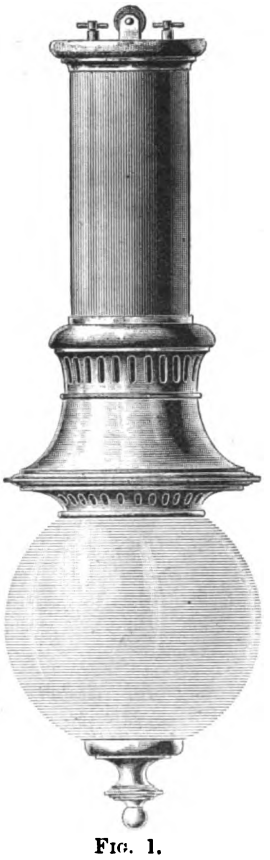

FIG. 1.

FIG. 2.

These lamps have been designed for use on low-potential circuits, particularly those supplied with currents from central stations. They work perfectly in single parallel, or two in series with 100 volts continuous current, four in series with 200 volts continuous current, or three in series (up to 15 amperes) with 100 volts alternating current.

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OUR TABLES.

We this week issue in tabular form information collected from authoritative sources concerning central stations, many of which are in operation, some are in preparation, and some only in contemplation. From time to time we have seen the information which the engineers to various local authorities have prepared for their committees and councils. Our columns contain, as far as we have been able to complete at present, the information which seems to be most in request by the local authorities. The progress of central stations has been rapid, and promises to be still more rapid. It has been our good fortune to contend from the very first that the generation and distribution of electrical energy should be in the hands of the local authorities, and not in the hands of companies. If men are not blind to the position of affairs, they will see from reading, say, Mrs. Green's "Town Life in the Fifteenth Century," that in the youth of municipalities the authorities were always jealous of outside interference. The town's affairs were carried out by the town's representatives. Then came civil wars and a decadence of interest in municipal work, and this lack of interest lasted till quite recent years. The energy and far-sightedness shown by several of the large provincial manufacturing towns in the early part of the later half of this century has borne good fruit, and all around new municipal interest is showing exuberant activity. The fiat has gone forth that municipalities must control sanitation, water supply, artificial light supply, and similar common matters. In all these directions the local authorities can do better and cheaper than companies, firms, or individuals. We were anathematised vilely and scurrilously in earlier days for standing out against the actions of prowling promoters of electric light companies. Many, however, who then doubted have changed their coats and agree with the correctness of our views. More and more municipalities are paying attention to lighting matters, and in many cases the mere fact that the gas is in the hands of a company makes it easier for the authorities to erect their own central stations. We do not assert that our tables are complete. It can be seen at a glance that they are not, but anyone who has had experience of attempting completeness in such things will readily admit that we have succeeded in getting together a mass of information that must prove of immense value to those authorities who are considering the matter. We claim to be saving the ratepayers in various towns a fairly large sum by means of this tabulation, for it will save their authorities the expense of preparing their own tables. Of course we shall correct, extend, and reissue periodically, and we trust our readers will not be afraid to send suggestions for making the information more perfect, or to fill up the blanks which are unavoidably left. The tables have been compiled by Mr. C. H. Biggs, jun., who has used as guides the local tabulations of Mr. Brown, borough engineer of West Hartlepool, and Mr. W. A. Davies, of Aston Manor. Great difficulty has been found in getting at the question of prime costs. It would be surprising to many of our readers to

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see the great divergences that appear even in published and audited documents. The figures given to put before shareholders are found to differ from the figures put before the Board of Trade. No doubt, then, there will be more or less violent criticisms; but this we expect, and rather court. We prefer a good damning to no word at all, because it helps us to see where we fail and to correct our errors. We know these criticisms are impersonal—not aimed at the individual, but at the error. It might be suggested in one or two cases that it was possible to have avoided the errors by concert with the authorities. In every case, and many time and again, applications have been made to the authorities, and in the majority of items the figures have been authoritatively given or corrected. Procrastination is the bane of compilers of tables. Application is made to the authority, but the reply is not received till too late—hence some tears. We are glad to say, however, that in the case of these tables the delays have been unavoidable, and mostly due to the fact that the books connected with the various stations are balanced at different times. But enough of excuse. There is just one other question which the publication of these tables makes prominent. Here are already some two hundred central stations more or less, added to which must be as many more private installations, requiring electrical engineers-in-chief, as well as assistants. Does the Institution sufficiently recognise this fact? Its members and associates are being largely recruited from this source, and unless sufficient is made of these recruits we shall find them longing for an institution of their own. They are mostly ex-metropolitan members, and their claims on the Council must be recognised. When we criticise the Council list as issued, it is too late to make alterations; hence the necessity of calling attention thus early to the subject.

COST OF ARC LIGHTING.

An interesting historical point arises out of the remarks made by Mr. J. S. Raworth in the discussion on Mr. W. Langdon's paper at the Institution, which we were obliged to give in a very condensed form in our last issue. The question is that of the cost of the first arc lighting for railway purposes. Mr. Raworth said that as far back as 1879 he had the honour of fitting up for the London and North-Western Railway Company the station and goods yards of Holyhead with the best apparatus they could then command. They had five arc lamps fed by five small Siemens dynamos, and separate cables to each lamp. Although that was a pretty considerable undertaking at the time, it had worked satisfactorily up to the present, and he believed it was still working. The next step that company took was to get Mr. Raworth to light up one of the passenger platforms in the Victoria Station, Manchester, by means of alternate-current arc lamps. That platform was a long, narrow one, and it was lighted at the exceptionally low price at that time of 2½d. per lamp hour.

Now, Mr. Langdon tells us that the average cost per arc lamp hour on the Midland Company is 1·316d., the highest figure being at St. Pancras, where it was 1·61d., and the lowest ·93d., at Lawley-street, Birmingham, where seven-ampere lamps are used. This is a very marked decrease on the above, but not quite so much as might be expected after the improvements made in engines, dynamos, and lamps during the past fifteen years. We fancy that the arc lamps used in the old days at Manchester used about ten amperes, and as they were alternating-current they would not give the candle-power obtained by Mr. Langdon with his direct-current arcs.

Coming to other systems where a profit is supposed to be made on the light, we are informed by Mr. Leonard that the South-Eastern Railway pay fivepence per unit for the arc lighting as an inclusive charge. Assuming fifteen-ampere lamps, it would cost them about 3·8d. per arc lamp hour, but the candle-power would be quite double that of Mr. Langdon's lamps, and the Charing Cross and Strand Company have to get their profit out of this. The Corporation of London pay £26 per annum for a ten-ampere arc lamp lighted from sunset to sunrise, with extra charges for fogs. This charge works out to 1·43d. per lamp hour, or to 2·86d. per unit.

It is well known that these figures for street-lighting were purposely fixed at an unremunerative rate by the promoters of the City of London Electric Light Company in order to get the other concessions from the Corporation, and we have official information to the effect that in 1894 the actual cost of the public lighting by the City of London Company averaged 2·92d. per unit, showing a loss of ·14d. per unit all round. We consider that the cost of arc lighting is now rapidly approaching its minimum while the present fuels and machinery are used for the production of the electric energy, but the question of cost per actual candle-power might still be ventilated with advantage. We shall be glad to receive actual figures of measured candle-power, together with cost of production, from any of our readers.

SHIP-LIGHTING PLANT.

The combined engine and dynamo here illustrated is one of a pair recently constructed by Messrs. J. P. Hall and Co., Blackriding Ironworks, Oldham. The engine illustrated gives 18 i.h.p. when running at 250 revolutions per minute with a steam pressure of 80lb. The dynamo is of the usual direct-driving type made by this firm, and is compound wound, giving at the speed stated 150 amperes at 65 volts. The armature is of the drum-bar type, the driving power being transmitted to the winding by means of strong flat driving pegs let into the core, which is positively driven through keys let into the shaft.

The insulation largely consists of mica. The commutator contains 91 segments of hard-drawn copper, each being 1½in. deep. The current density in the armature conductors is below 1,000 amperes per square inch of section, and the rise in temperature does not exceed 70deg. F. after a 10 hours' run with full load.

The engine is fitted with the firm's new patent automatic expansion gear, shown in Figs. 2, 3, and 4. The governor disc is in two parts. The part F is keyed to the shaft, while the part G, Fig. 3, is an annulus connected by bolts and distance-pieces, V, to F, leaving an intermediate space, in which are contained the weights, I I, and the springs, M M, as shown in Fig. 2, which represents the disc, G, removed to display weights and springs. The weights are pivoted at H H, the upper one being provided with a tail piece so that the two weights can be connected together

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by a flexible bar, K. Each weight has connected to it by a stud, L, and eyebolt, round which is coiled the helical spring, M. The eyebolt passes through a swivel lug, O,

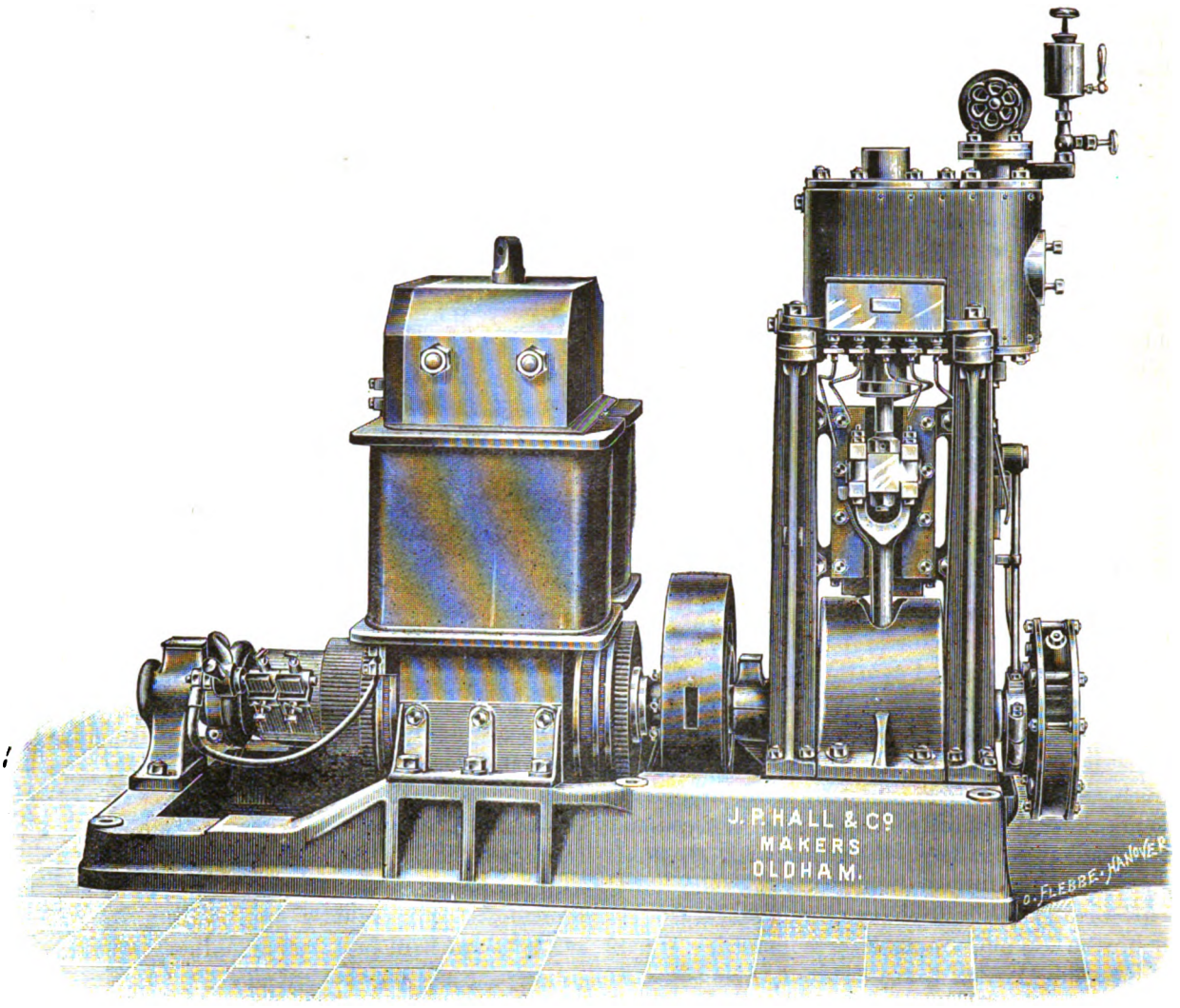
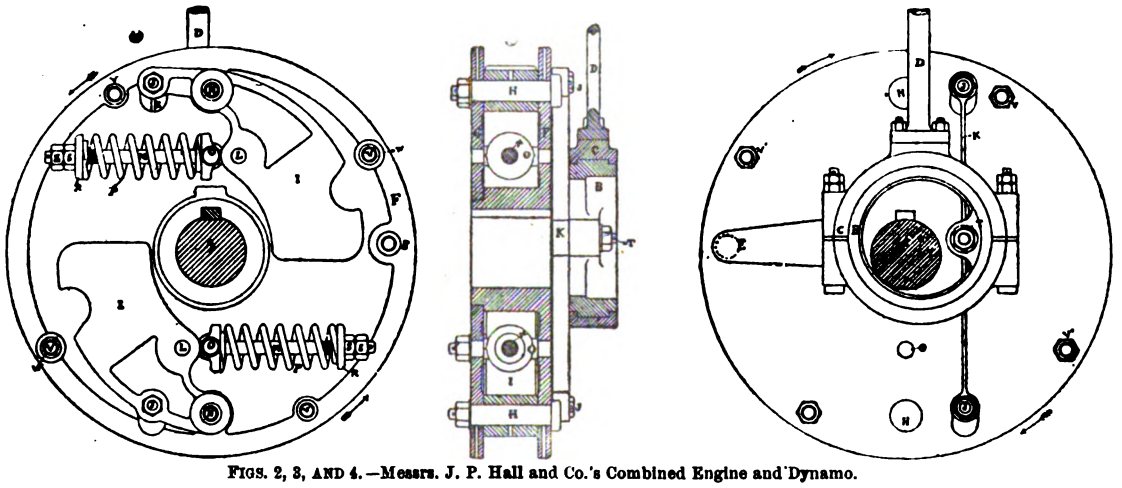


FIG. 1.—Messrs. J. P. Hall and Co.'s Combined Engine and Dynamo.

pivoted and free to revolve in the discs, F and G. The compression of the springs can be adjusted to balance the centrifugal action of the weights within a certain variation



FIGS. 2, 3, AND 4.—Messrs. J. P. Hall and Co.'s Combined Engine and Dynamo.

of speed by means of the lock nuts, S S. The flexible bar, which replaces the numerous connecting rods, pin, and joints hitherto used, is on the outside of the disc F, and takes on to the studs, J J, on the weights. These studs pass through slots in the disc, Fig. 4. At the centre of the bar is a forged eye that embraces a stud, T, on the eccentric, B. The eccentric, which has a large eye to enable it to move relatively to the shaft, has an extended ear pivoted to the disc at E. When the weights, I I, move in or out, owing to variations in the speed of the engine, the flexible bar, K, shifts the eccentric to vary the cut off. At the minimum travel of the valve the port is only opened by the amount of the lead, and at all other cut-offs the lead remains the same. The governor can be used for either right or left hand by reversing the position of the parts. It is exceedingly compact and powerful and works exceptionally easily, there being hardly any friction, and, as will be seen from the construction, will run for a long time without attention or developing slack joints.

Richmond (Surrey) Electric Light Company.—At a meeting of shareholders of this Company on Tuesday last the following directors were elected: Mr. F. W. Reynolds (director of the City of London Electric Lighting Company), chairman; Mr. W. C. Braithwaite (director of the County of London and Brush Provincial Electric Lighting Company); and Chevalier Soares. At a subsequent meeting of the directors, Mr. A. J. Lawson was appointed engineer and manager, and Mr. G. A. Luke, secretary, *pro tem.* Mr. Percy W. Northey remains resident engineer.

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EFFECTIVE ELECTRIC LIGHTING.

BY W. PERREN MAYCOCK, M.I.E.E.

(Concluded from page 402.)

While on the subject of arc lighting, a few remarks on the ordinary use of arc lamps will not be out of place. The usual plan is to enclose the arc in a globe or lantern made of opal or ground glass. The former material absorbs from 50 to 60 per cent. of the light, while ground glass, according to its density, absorbs from 30 to 50 per cent. It will at once be seen how extremely wasteful is the usual method of dispersing or attempting to disperse the light rays. It is really only necessary to disperse the downward rays: the upward ones should be unobstructed, and then thrown down by a reflector. A lamp fulfilling these conditions, and made by Messrs. Joel and Co., of Wilson-street, Finsbury, is shown in Fig. 6. Here it will be observed that the bottom half only of the globe is opal, the top half being of clear glass, the opal hood serving to reflect the upward rays downwards. This form of lamp is a great deal superior to ordinary forms used in street illumination. In fact, the usual practice of outdoor arc lighting is very crude and unscientific. In spite of the globes, the lamps have a dazzling effect on the eyes if looked at for a few seconds, and sharp shadows are thrown, two things to be especially avoided in outdoor lighting. The lamps are put at a height of 18ft. or 20ft. in order that the light may be

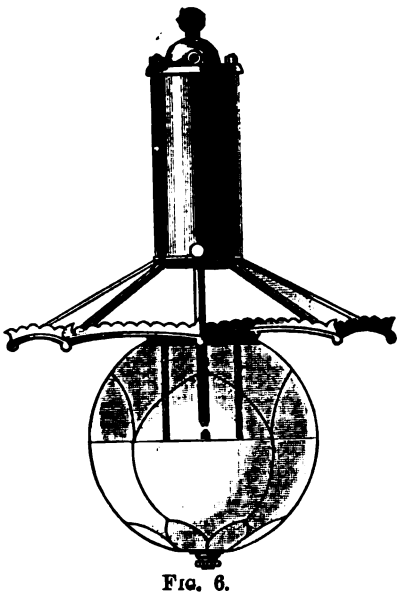

FIG. 6.

cast over a large area, and also that they shall not easily catch the eye. Much light is lost by placing the light so far above the ground, the height being also necessitated by the distance apart at which the lamps are placed. It is here suggested that more effective street illumination would be obtained by using lower candle-power lamps, placing them proportionally nearer together, at, say, the height of an ordinary gas lamp, using hoods of the pattern shown in Fig. 6, and making the bottom half of the globe semi-opaque, while of course retaining the interior reflecting surface; care being taken in the case of a direct-current system to have the positive or crater carbon at the bottom. The bottom half of the globe might be tinted a deep orange colour, which would give a very pleasing effect without glare.

Experiments have been made by Mr. A. P. Trotter in England, MM. André Blondel and Psaroudaki on the Continent, with clear glass globes and shades having prismatic corrugations on their surfaces, called variously dioptric or holoplane shades. These experiments have been entirely successful in obtaining a good diffusion of the light with little absorption, but difficulties of manufacture, added to the dirt-harbouring propensities of the corrugated surfaces, have done much to retard their adoption. However, the holoplane shades and globes of the two continental inventors, which differ in many respects from the devices of Mr. Trotter, are now being manufactured by Messrs. Englefred and Co., of Paris, and are being so well taken up on the Continent that it is very likely they will soon find their way into this country. These are made for both arc, incandescent, and other lights, and should find special favour for interior illumination, where they are not so liable to become dirty.

Let us now return to the consideration of incandescent lamp illumination, which has already been referred to at some length. Owing to the much less intensity and higher cost of the incandescent light as compared with the arc light, the lighting of interiors with reflected light from hidden lamps is necessarily rather an expensive matter. But where expense is no object, the effect obtained is all that could be desired, the light being warmer in tone than that from the electric arc. St. Peter's Church, Eaton-square, London, has been lighted mainly on this principle, the lamps being hidden as much as possible from the direct view of the congregation. In this instance 260 16-c.p. incandescent lamps replaced no less than 640 gas-jets. Freemasons' Hall, London, is lit by shaded incandescent lamps arranged around the frieze and on the ceiling.

It is only in rooms where the decoration of the ceiling and walls is in light colours that illumination by reflected light can be carried out, unless of course an unusual number of lamps are used, dull surfaces absorbing a considerable percentage of the light. In such cases the light should be thrown direct from the lamps through their shades. With a given method of shading the lights and a given size of room, the number of lamps required to give efficient illumination will depend upon the nature and colour of the surroundings; thus a dark wainscoted room would require more lamps than one with ordinary wall-paper and a whitewashed ceiling.

An excellent effect for any kind of room is given by the use of electric candle lamps, provided with suitable silk or paper shades. The flutings on the lamp bulb give a flame-

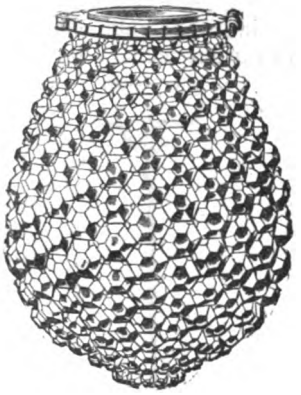

FIG. 7.

like appearance to the light when viewed from a distance, so that the dazzling effect is lessened; but still the shades should be arranged well over the lamps, so that the latter are seen as little as possible.

The majority of fittings, both electroliers and brackets, are arranged for the lamp to be hung downwards. This is a great mistake, as the shades offer little or no protection for the eyes. In some cases this difficulty is overcome by putting on a second shade under the lamp, so that an unnecessary amount of light is absorbed. Most of the usual forms of wall brackets would answer much better if they were put up upside down: the downward rays would then be more or less dispersed, while the upward ones would be quite unimpeded; care being taken to place the brackets at such a height that the top of the lamps were just visible when standing on tiptoe.

When downward hanging lamps are preferred, the lamps should either be shaded, or the bulb of the lamp should be frosted or treated with some composition which will prevent the filament itself from being seen. Of such shades there are numberless varieties, good, bad, and indifferent. Opal and ground-glass shades as a rule absorb too much of the light; while plain or coloured transparent shades will permit the filament to be seen, and will not disperse the light. Cut and etched glass shades best fulfil the required conditions. Fig. 7 illustrates the bead ray diffuser, the shade being built up of crystal or tinted cut-glass beads. If downward hanging lamps must be used, and the cost of shades cannot be

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incurred, the globes of the lamps themselves should not be plain. Most makers supply lamps with frosted globes, and Messrs. Slade, Templeton, and Co., of 15, New Broad street, London, supply lamps with etched globes. Ordinary lamps can be treated with various compositions. The Luminous Enamel Syndicate, of 37, Cursitor-street,

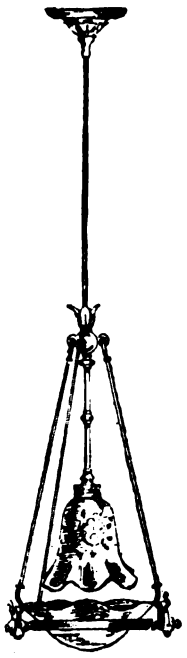

Fig. 8.

Chancery-lane, E.C., make a luminous enamel which, when applied to the lamps, entirely hides the filament, at the same time dispersing the light very effectively. This enamel is made in various colours, but the white is to be preferred for general purposes. Another composition,

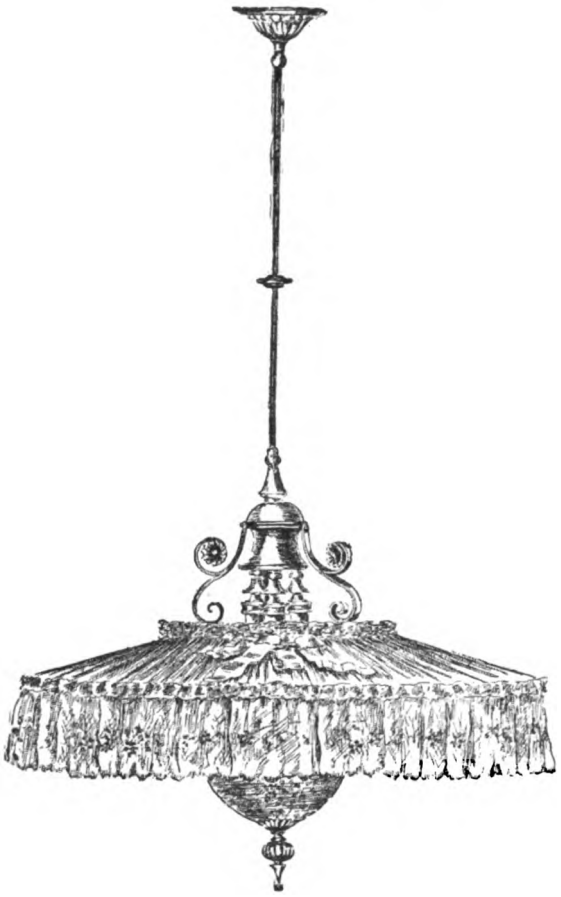

Fig. 9.

called "Snowflake," is made by Messrs. V. Fabris and Co., of 171, Drummond-street, Hampstead-road, London, N.W. Yet another is "Shaydolite," supplied by Messrs. Griffiths Bros. and Co., of Mack's-road, Bermondsey, S.E. This latter is of the nature of a varnish, and is made in various colours. "Shaydolite" being transparent, does not diffuse the light to any great extent, and does not hide the filament, but it is much used for theatrical and similar purposes where coloured lamps are a feature of the decorations. The advantage of these compositions is that they may be applied to the whole or part of the lamps. According to the position of the latter with regard to the eyes, it is well to treat only those portions through which the filament would otherwise be seen, leaving the rest untouched, thus impeding as little as possible of the light.

In selecting fittings, the guiding principle is thus to have only those in which the filament of the lamp is shaded from the eyes, but exposed on those parts not directly in view. Fig. 8, for example, shows a rational form of hall lamp. The lamp is entirely shaded from view, so that no direct rays can be seen. It may be said that the top shade is rather unnecessary, but then it must be remembered the light has to be screened from persons descending the stairs, as well as from those on the floor. Fig. 9 (which, as well as Fig. 8, has been lent by the General Electric Company) illustrates a table pendant lamp with cut-glass bowl, which serves to prevent the direct rays from the filament to some extent from striking the eyes. In fittings provided with bowls, like Figs. 8 and 9, a most pretty and artistic effect can be obtained by arranging natural flowers in the bowls, the flowers and leaves serving to obstruct the direct rays from the filament. Many forms of wall bracket are designed on this principle.

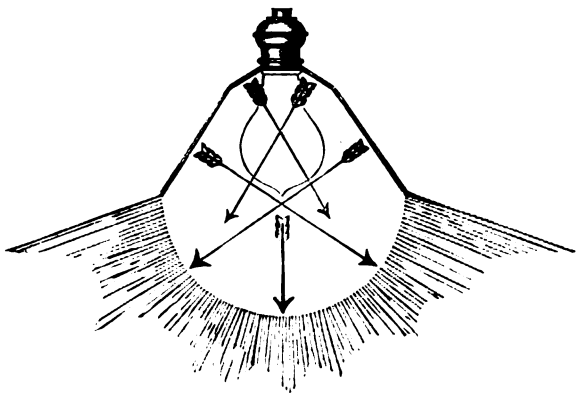

Fig. 10.

In Figs. 1, 2, and 3 are illustrated various forms of fittings which are specially adapted for shop-window or showroom lighting. A great deal might be said of this special branch of lighting, were space available. A walk down Oxford-street, for instance, at night-time will reveal the deplorable fact that in many cases the light has been unskilfully arranged, not always on the score of economy, as evidenced by the style of the fittings, but through sheer ignorance of what constitutes effective electric lighting. On the other hand, there are some installations that have been very well carried out, and which may be studied with advantage by those who contemplate undertaking similar work.

Enamelled iron shades or reflectors are a good deal used in some installations, and their efficiency depends much upon their shape. Fig. 10 gives a section of a shade made by Messrs. Verity and Sons, of King-street, Covent-garden, W.C. The figure shows by means of arrows the directions in which the rays from the lamp are reflected, and it will be seen that a good spreading out of the light is obtained.

In concluding this series of articles, it is hoped that the main points which must be attended to if artificial lighting is to be a success, have been sufficiently impressed upon the reader. Much more might have been written on this subject, but all would have tended to the same end, which may be summed up in two words—*reflection* and *diffusion*.

Referring to the holoplane glass globes mentioned above, since writing this article I hear that Mr. S. M. Scott has been appointed British representative and agent of M. Blondel's system. Mr. Scott's office and showrooms are at Cornwall Building, 35, Queen Victoria-street, E.C. Here the globes are to be seen fitted to all classes of lights—electric, oil, and gas.

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MOUNTAIN-CLIMBING RAILWAYS.

BY ERNEST SCOTT.

The building of an ordinary railway, working by adhesion in mountainous districts, generally presents serious difficulties, and involves an expense in construction which is in excess of the return the line can make to its promoters. As a rule, the limiting grade is 1 in 40, and in order to keep within this limit the line must traverse a much greater distance than the direct route between the termini. This will probably include many engineering works, such as viaducts, embankments, walls, deep cuttings through solid rock, etc. For most mountain railways, therefore, some expedient, such as the rack and pinion, has to be used, and experience has shown that the rack may be employed without danger on gradients so steep as 1 in 2·5. While the construction per mile of track is much more costly than that of the ordinary railway, they are yet more economical from the fact that the distance between the termini is much reduced, an almost straight line being followed.

Switzerland, the happy hunting ground of the tourist, is peculiarly the home of the mountain railway, and by its means many of the peaks formerly inaccessible to the ordinary tourist can now be easily and quickly reached. The grand Alpine scenery alone would ensure its fame as a popular resort had it no other claims, but to specialists in various departments it presents an attractive field for the pursuit of their favourite study. In common with workers in other branches, the engineer meets with examples which have an especial interest for those of his profession, and which will arouse that close habit of observation which his work requires and creates. In Switzerland the engineer has achieved some of his cleverest feats. Such are the great water-power works at Schaffhausen and Fribourg, where wire ropes convey the hundreds of horse-power that are obtained from the swiftly flowing rivers all over the town, furnishing cheaply to manufacturers the means of driving their machines. They have impressed the dynamo into their service, and are ready to instal the electric motor in the most inaccessible of villages. Remarkable constructions, too, in many cases, are the bridges thrown across the rivers by the railway companies, while the difficulties overcome by the engineers of the many narrow-gauge and mountain railways have placed these lines among engineering wonders For the study of mountain railways nothing, indeed, could be better than a tour in Switzerland, for, while there are elsewhere isolated examples of similar construction, in the Alps a variety of systems can be examined at work on lines of the greatest difficulty. Judging from the number which have been built lately, and those that are projected, these railways seem to be an excellent investment, and that in spite of the enormous cost per mile in construction and the small mileage run in a season. Of course the wear and tear is comparatively low, whilst the rates are high. A few figures may be interesting.

According to official statistics, over 1,600,000 tourists visit Switzerland every year. The authorised passenger rate is 1s. 3d. per mile, yet in 1890 the Rigi line carried 101 000, the Pilatus 37,000, the Utliberg 68,000, Rothhorn 36,000, and the Generoso 20,000 passengers, the working season being limited from June to September, and the passengers in all cases being counted separately for ascent and descent. The working expenses of the above lines give an average of 47 per cent. of gross receipts, although on the Rigi and Pilatus the cost per train mile works out at nearly 10s. The net return on the capital invested is—Rigi 7 per cent., Pilatus 5 per cent., Utliberg 2 per cent., Rothhorn 5·5 per cent, and Generoso 2 per cent. The Swiss Government do not impose very stringent conditions on the promoters of these railways. The concessions are generally for a period of 80 or 90 years, with power to purchase at the end of 25 or 30 years. The authorised maximum speed on a gradient of 25 per cent. is four miles per hour, and on gradients of 40 per cent. and upwards one metre per second, or 2·3 miles per hour. These are, however, often exceeded, and could in most cases safely be doubled. Ten miles an hour is quite a common speed on gradients of 8 and 10 per cent. In case of bad weather the traffic regulations are such that if those responsible think necessary the trains may be delayed running. The Railway Department of the Government exercise the strictest supervision upon the material used on these railways, tensile strength tests, etc., being made at the Federal Testing Office at Zurich. The cables on cable railways and their connection with the cars are officially examined twice a year. They have to be renewed as soon as the tensile strength is less than four times the maximum working stress.

The difficulties that have to be guarded against in laying the line are: (1) Landslips or avalanches. The rails should be laid in sheltered situations, even if specially sharp curves are necessary. (2) Ordinary ballasting and sleepers are out of the question. Special precautions have to be taken to prevent creeping downhill, and yet at the same time ample allowance must be made for expansion and contraction for the differences in temperature, the differences of temperature in such situations as rack railways are generally placed in being very considerable. (3) The lack of adhesion, owing to the diminished action of gravity, has to be met. (4) Arrangements must be made to prevent the car being blown over by wind if surprised by one of the furious tempests and violent gusts of wind which are sometimes encountered at high altitudes. The avalanches constitute the principal difficulty in laying out Alpine railways, and their courses—indicated by scratchings on the ground—have to be carefully studied and avoided. On those lines worked by electricity, and which are much exposed to atmospheric discharges, efficient lightning arresters must be provided. In Switzerland they generally take the form of the ordinary toothed discharger, with impedance coil, condenser, and cut-outs.

Among the early devices for climbing steep grades was a plan for equipping the regular locomotive with a pair of horizontal friction rollers, arranged to press against a smooth centre rail and operated by a special set of cylinders. The Fell system is a development of this, and it has been adopted on the Wellington and Featherstone incline, New Zealand. The gauge is 3ft. 6in, and the gradient, averaging 1 in 15, is two and a half miles long. A train weighing 53 tons is drawn by an engine weighing 36 tons. The saving in capital cost in this case by the Fell railway, instead of an ordinary line, is estimated at £100,000. It has also been used on an extension of the Cantogallo railway in Brazil.

In the Fell system there is increased journal friction due to the pressure in keeping the gripping wheels in adhesion with the centre rail, whereas in the rack, friction, when there is any, is due to the imperfect adaptation of the pinion to the rack. The first is independent of the curvature of the road, while the other increases rapidly with it. There is, of course, some radius of curves at which the two systems would be equally favourable, an increase of the radius tending to give the superiority to the rack, while a decrease would tend to give it to the Fell system. Curves of as low as 140ft. radius can be traversed with facility working on the Fell system. It was customary to sand the centre rail, but the gripping wheels are now generally turned to the profile of the rail, and thus give ample adhesion In descending an incline, jets of water are played on the centre rail just in advance of the brake in order to cool it. The brake also lasts longer than when applied to a dry rail.

With the water-ballast system the cars are provided with suitable tanks. A load of water is taken on the car at the head of the incline, which causes it to descend with sufficient force to haul the other car up the gradient. On reaching the bottom the water is discharged from the first tank, while the one at the top is again filled. By alternately filling and discharging the tanks the cars are kept in operation. Where water can be got for nothing, or very cheaply, the water-ballast system is often used - *e g.*, the cliff railways at Scarborough and elsewhere—and also on several mountain railways, of which that from Lauterbrunnen to Grutsch is, perhaps, the most interesting. As the water ballast in the descending car is sufficient to start and haul the ascending car, the expense and maintenance of generating station machinery, and also electric motors on some of the lines, such as Monte Salève, is dispensed with. There are disadvantages, however: the ballast water weighs very heavy, and necessitates the frame and body of the car being made stronger to carry the tank so that the amount of the dead-load is out of proportion to the average passenger load. Thus on the Lauterbrunnen Cable Railway the weights are as follows: empty car, eight tons; water, seven tons; 40 passengers, three tons. These loads require correspondingly heavy cable winding drums, pulleys, etc. A ballast cable for the purpose of balancing the weight of the main cable, and thus reducing the requisite pull, is sometimes employed, as, for example, St. Beatenberg on Lake Thune and also at Bienne. This second cable reduces, but does not remove, the disadvantage of the ballast water. Mr. George Croydon Marks has gone very thoroughly into the water-ballast system, and at Lynmouth (Devonshire) and (Clifton) Bristol and elsewhere has applied a system of electric signalling, whereby the amount of water introduced into the top car-tank is regulated to suit the number of passengers who are to be brought up in the companion car, thus materially economising the cost of water.

The ladder rack was first used by Marsh on the Mount Washington line in the United States, and in Europe by Riggenbach on the well-known Rigi Railway. The Riggenbach ladder rack consists of two channel bars placed back-to-back, and 5in. apart. The bars are bolted together with trapezoidal rungs of steel, which serve as teeth, and are so disposed as to engage three teeth of the pinion wheel. The whole is bolted to cross sleepers, and the ends of each length are further secured to the sleepers by angle irons. Nearly all the more recent lines have been laid down on the Abt system, a description of which follows. The line at Barmen is, however, an exception; here the ladder rack had to be used because part of the line is laid in the public road. The Wengern Alp is also another exception. Although the ladder has come into quite extended use, it has serious inherent defects which incapacitate it for high speeds. The prime requisite for a smooth and quiet motion is uniformity of pitch, and it is almost impossible to manufacture a long ladder rack without introducing elements of error. Again, the diameter of the pinion to secure proper contact with the teeth is so large that the power from the steam cylinder has to be transmitted to it by multiple gearing. The tendency of modern practice has been to abandon the ladder and adopt a rack which is essentially built up of two or more individual racks placed side-by-side. The idea or principle is the same as that which led up to skew bevel, and afterwards to the well-known double helical gear. As applied to railway work, it is known as the Abt system, and is employed to a considerable extent.

The Abt double rack generally consists of two steel bars, 1¼in. thick, and placed 1½in. apart in such a way that the tooth in one plate is opposite the space in the other plate, "staggered" with respect to one another. The rack is attached to alternate sleepers by T-shaped chairs, to the web of which they are fastened by transverse bolts, the chair itself being fastened to the centre of the sleeper by stout bolts. This kind of rack lends itself to economy of material very readily, because on gradients of less than 10 per cent. only one rack bar is used, with, of course, only one pinion working in it. Above 10 and up to 25 per cent. both rack bars and the two pinions are in operation; in the former the pinions have a double and in the latter a fourfold grip. The

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motion is more continuous and obviates the slight hammering of the pinion teeth incidental to the ladder rack. This is of great advantage where electric motors are used as the propelling power. Loose connections at the commutator joints are not caused by the unevenness of the roadways so much as by the load coming off and on as each tooth of the pinion engages and disengages with the line rack. As there are over 300 miles of the Abt track already constructed in different parts of the world, we may take it that it has effectually vindicated the advantages it claims as compared with other forms of rack. As a general rule these rack railways are isolated, having no immediate or material connection with adjacent systems. There is, however, on the Continent a growing number of continuous lines traversing mountainous districts. They are operated by locomotives having a double set of cylinders. One set actuates the ordinary wheel adhesion system in the usual way on the level or low grades, and the other set is brought into use additionally for working the rack pinions on the steep grades. This is known as the Abt rack and adhesion system, and it is to be hoped that the extensions soon to be made in this country in the direction of light railways and tramways will afford instances where lines of this character may find advantageous employment. On lines of this combined system it is, of course, important that the rack rail be properly entered by the pinion without slackening the speed of the train. This is accomplished by laying down a special entering rack rail. It is about 10ft. long, and is hinged to the rack at one end; its free end rests upon strong spiral springs, which allow it to give slightly. The teeth towards the free end gradually diminish in height, giving it a wedge-shaped appearance. As the locomotive passes over the entering rail the pinion is turned by friction, and within a few feet a true interlocking of the teeth is secured, when steam is admitted to the extra pair of cylinders for climbing the gradients. The rack wheels are almost always vertical—that is, their plane of rotation is parallel to the road wheels. An exception is the very heavy gradient on the Mount Pilatus Railway. There the danger of the pinion rising out of gear when full work is on, owing to the diminished action of gravity, is overcome by having two horizontal pinions working into racks which are back-to-back. This is Colonel Locker's invention. The difficulty can be met with the ordinary Abt rack, however, by fixing to the bottom of the car two vertical anchor bars, which travel between the rack bars, and whose flanges press on the bottom surface of the rack bars in the event of the car rising. This has been done on the Burgenstock line, which has a gradient of 58 per cent.

The rack on the St. Ellero-Saltino Railway is the invention of Count Joseph Telferer. It is built up of bars of Siemens-Martin steel angle bars, thickened up at the teeth with plates. This rack is cheaper than the others. It costs about 14s. per lineal yard.

Another type, known as the Agudio system, is in operation near Torrino, Italy. In this system a small wire rope driven from the terminal station in the same manner as for cable lines, is led over two sheaves attached to the side of the motor car, and by means of reduction gear transmits power to two horizontal cogwheels, which embrace a central cog or rack rail, and propels the motor with sufficient power to push a train of several cars on a gradient of 38 per cent. The cog-rail is of peculiar construction, being a steel ribbon bent zig-zag in such a way as to present teeth on each side. This is fastened by means of channel bars and bolts to a central beam. The motor is in a measure independent of the cable, and by means of friction clutches the train can be stopped or run backwards.

The first rack railroad that was ever built is without a doubt the one put down by Blenkinsop in 1811 between the coal staith at Hunslet, Leeds, and the Middleton Colliery, Mr. Blenkinsop being manager and part proprietor of these collieries. As there was a steep gradient at the Middleton end of the line it was thought (and rightly too) that with the light weight of engine which was being built that sufficient adhesion could not be obtained between smooth wheels and rails. A cast-iron rack was therefore laid down alongside the ordinary rail. As Blenkinsop knew little about engine-building, he gave the order for the engine to Matthew Murray, of the Round Foundry, Water-lane. Murray is one of the many engineers of whom Leeds has good reason to be proud. He was one of the first to take up stationary engine building in this country, and as an example of the work he did may be mentioned the fact that an old beam engine which he built is still used for driving the works at the Round Foundry, a counterpart of this same engine being also the first to be set to work in Russia. Murray's engine ran its first trip in August, 1812, just 8½ years after "the father of the locomotive," Trevithick, had run his first and only engine on the Penydarran cast-iron tramway, near Merthyr Tydfil, and two years before George Stephenson's first engine "Blucher," was set to work on the Killingworth railway. Murray's engine had two cylinders, and the energy was communicated by connecting rods and crank to a large cogwheel, which worked in the rack fastened to one of the rails, the four ordinary wheels of the engine being simply supporting wheels. Locomotives of this design conveyed coal from Middleton to Hunslet for several years.

The next rack railway was built by Sylvester Marsh up Mount Washington, New Hampshire, U.S.A. It was opened in 1869, and was 3·29 miles long, with a maximum grade of 37 per cent., the minimum being 10 per cent. The rack is in the form of a narrow ladder, having angle iron sides and rings of round bar iron 1½in. in diameter placed 4in. apart. The rack and track rails are spiked to wooden sleepers, which are securely anchored by straps and bolts to the solid rock formation.

The summit of the Rigi can be reached from Vitznau, on the Lake of Lucerne, or from Aarth Goldau, on Lake Zug, the first-named being the oldest and steepest route as well as the best paying. The track has a standard gauge of 4ft. 8½in., and is carried on sleepers that rest on solid rock which has been cut out to a depth of 1ft. to receive them. At Freibergen, a station midway on the line, there is a passing place of peculiar construction; it consists of a sector of sufficient length to contain the locomotive and car. When the train has passed on to the sector, which is hinged by an iron pivot and provided with wheels, it is turned round until the line is clear and the opposing engine is allowed to pass. The locomotive weighs 12½ tons, and has a vertical boiler arranged to be perpendicular on an incline of 1 in 4. There are four flanged supporting wheels, and on the rear and front axles are mounted the cast-steel rack pinions. Passengers make the ascent in two storeyed cars, designed to carry 46 in the lower and 36 in the upper compartment. Although the Rigi is 1,000ft. higher than Ben Nevis, the hotels on its summit are crowded during the season with tourists who have come to see the sunrise or sunset, whose attractions have been so often described.

The railway to the summit of Mount Pilatus (so called because by tradition it was the mountain from which Pontius Pilate finally ended his life by throwing himself into the Lake of Lucerne) was first surveyed in 1885. The grades of this line being very severe, the builders had to adopt a new type of road invented by Colonel Locker. The rails are placed on iron ties, the latter being firmly fastened to granite blocks on a substructure of solid masonry. The car wheels are without flanges so as to reduce friction, the train being kept on the track by the centre rack, which forms a sufficient guide. There are two racks placed back-to-back, or teeth on either side, into which four horizontal toothed wheels gear, two at the forward end and two at the rear end of the car. With the axes of the driving wheels being at right angles to the plane of the line, any tendency to rise out of gear is mutually resisted, and thus perfect security is obtained as far as regards danger. The rack is in lengths of 10ft., the teeth being milled out of solid steel bars. The engine is by the Locomotivefabrik Winterthur, fitted with self-adjusting cylindrical valves and Brown's patent valve gear. In order to save weight and give greater security, engine and car are combined. The whole vehicle is carried by two axles, upon which it is supported at three points—namely, at the centre of the leading and at the ends of the following axle. The horizontal multitubular boiler is placed transversely to the track so as to keep the water on a level. There are specially arranged clips, which are fitted over the rail heads in order to prevent the car from being blown over by the wind if surprised by one of the furious tempests which are sometimes encountered at these high altitudes. The clips are made long enough to prevent jamming, and the connection with the frame of the carriage is such that a small amount of vertical play is allowed in the direction of the length. The cars are protected by two hand-brakes, one ordinary air-brake, and an automatic brake, which fits into the gear teeth and is operated by a wedge when the speed exceed 3½ miles per hour, so as to eliminate any chances of danger through inattention of brakesman or drive. The principle of using the cylinders also as an air-brake was first applied by Riggenbach on the Rigi line; it has had many applications since, notably the Rothhorn engines. In coming down, the motion of the wheels being of course reversed, air is sucked in at each stroke of the piston and pressed into the steam-pipe. If it is not let off by means of the special stop-valve in the driver's cab the pressure rises and gradually arrests the motion of the pistons. The driver regulates the air stop-valve just as he does the steam-regulator in the ascent: the more the valve is opened the greater the speed, and *vice versâ*. It is interesting to note that electric brakes are fitted on the Mount Salève, which act in just the same way, the electric motors working as dynamos on the descent.

(To be continued.)

INCRUSTATIONS ON INSULATORS.

The following is the report of the committee of members of the Royal Society and the Institution of Electrical Engineers appointed to confer with the electrical adviser to the Board of Trade with regard to the circumstances connected with the formation in large quantity of an alkaline deposit on the mains of the St. Pancras electric light supply, and the presence in this deposit in some cases of the alkaline metals in an unoxidised condition:

The committee have held three meetings, and a *précis* of the proceedings at these meetings is attached to this report.

After taking evidence as to the present condition of the mains of the St. Pancras electric lighting system, and after receiving from Prof. Thorpe reports of analyses, made under his direction, of the chemical composition of the incrustation found on the insulators of these mains, and of the salts contained in the bearers of these insulators, the mortar and concrete of the conduits, and the adjacent soil, the committee are of opinion that the explosions which have occurred were caused by the firing of an explosive mixture of coal gas and air by sparks caused by means of the above-mentioned incrustation.

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It has been proved that sparks may be caused either by the incrustation itself acting as an imperfect electrical conductor, or by moisture coming into contact with metallic sodium or potassium, both of which metals have been found to exist within the incrustation.

These metals have been produced by the electrolytic decomposition of alkaline salts chiefly derived from the soil, and conveyed by moisture along the fibres of the wooden bearers towards the negative conductor.

To avoid a repetition of these accidents, the bearers of the insulators at present in use should be replaced by other devices through which moisture is prevented from travelling, and it is recommended that the pattern of insulator in use should be changed, and a pattern adopted in which a longer insulating surface is interposed between the conductors and the bearer.

The committee is also of opinion that it is desirable that means should be provided by which the conduits can be inspected throughout their length, so far as is necessary to detect incrustations on the insulators.

The committee have not thought it within their province to investigate the causes of the presence of coal gas within the electric lighting conduits, but it is obvious that this is the primary source of danger.

(The report is signed by Major P. Cardew, Lord Rayleigh, Prof. T. E. Thorpe, Prof. William Crookes, Mr. R. E. Crompton, Mr. Alexander Siemens, and Prof. Alexander B. W. Kennedy.)

The following is the *précis* of the proceedings of the committee :

Meetings of the committee have been held on March 4, 8, and 22.

At the first meeting, Mr. Baron, chief engineer of St. Pancras Electric Light Works, gave detailed evidence as to the deposit or incrustation on the insulators on the St. Pancras mains, from which it appears that it was first noticed about 18 months ago, and found to be alkaline ; that 60 to 70 per cent. of the whole number of insulators which can be examined—*i. e.*, those in or near the street boxes—are affected by it, and that in some cases when scraped off it forms again within 24 hours ; that the insulators which are supported on wood bearers at the various street boxes are those generally affected, and only in two or three cases has any incrustation been found in the intermediate insulators within the culverts, which are supported on iron brackets. These wood bearers have become thoroughly saturated with saline moisture. They are supported at each end by being let into the brick sides of the culvert, and in some cases the end fibres of the wood may be in contact with the soil. Mr. Baron has seen the deposit flame with a yellow sodium flame in several instances when water was dropped on to it, or when it was dropped upon wet ground. He has also seen sparking from the negative main over the insulator to the wood bearer, and has produced the same by experiment with a solution of the material deposited. The insulator in this test was moistened on the surface with clean water, and the wood bearer was standing in the solution. The sparks occurred in about five minutes. The glaze on the insulator has been attacked in some cases. He does not think that the process of salting the streets in order to melt snow has any connection with the formation of the deposit.

Mr. Miller, of the Kensington and Knightsbridge Electric Lighting Company, also gave evidence as to leakage from the negative main always attracting moisture, and stated that a negatively charged cable belonging to his company laid in the subway at Kensington Court had a small fault of insulation, which apparently gave rise to a moist efflorescence on the adjacent brickwork, which if brushed with the hand emitted a sort of phosphorescent light in the dark. His company had experienced no trouble from incrustation on the insulators, but very high-quality insulators of hardened glass or porcelain and of the double-shed pattern were used. In their system every insulator used can be easily examined.

On March 6 Lord Rayleigh, Prof. Crookes, and Prof. Thorpe visited the St. Pancras mains. At a street box near the Chester Gate, Regent's Park, a piece of incrustation in a moderately hard and friable condition about the size of a hazel nut was taken from the negative main. This was placed on the cover of the street box, and some water put on it, when it broke into flame. There appeared to be several nodules of metal, one about the size of a pea. This metal was solid. Some flashes of sodium flame were also seen along the wood bearer as if the metal had been deposited there. The wood was saturated with moisture, especially under the negative. This wood bearer was subsequently sent to Prof. Thorpe for examination. At the places corresponding to the position of the negative mains the wood was much blackened and carbonised and very wet. On cutting it into six pieces it was found that the wood was saturated with alkaline salts, which were strongly caustic near the negative main, and chiefly carbonates of potash and soda at the ends. The soil, mortar, and concrete at this point have also been tested by Prof. Thorpe, and his analysis appears below.

At the second meeting of the committee Mr. Crompton produced three specimens of deposits taken from the insulators of the Southampton electric light mains. These have also been analysed by Prof. Thorpe (see below). Prof. Thorpe produced an analysis (see below) of three samples of the deposit obtained from the St. Pancras mains. Considerable discussion took place as to the exact process by which the incrustation and the free metal were produced, and it was finally decided to have another meeting before reporting.

At the third meeting, on March 22, further specimens from the St. Pancras mains were examined and Prof. Thorpe's analyses were considered. A glass insulator from the Southampton mains showing a considerable amount of deposit, was also submitted. The report was then discussed and adopted.

ANALYSIS OF DEPOSITS OBTAINED FROM ELECTRICAL MAINS.

Sample from St. Pancras Mains, received March 2.—The substance had the composition :

Caustic soda	7·69 per cent.
Caustic potash	4·88 ,,
Sodium carbonate	34·40 ,,
Potassium carbonate	52·77 ,,
	99·74 ,,

(+traces of silica, alumina, and lime.)

Three Samples from Southampton, received March 9, 1895.—All are practically pure sodium carbonate, with a very small admixture of potassium carbonate. The sample taken from the earthenware insulator is amorphous, and contains appreciable traces of calcium carbonate ; the other two (from glass insulator and distributor) are crystalline, and free from all except adherent impurities. None of the samples contain free alkali.

Soil, Mortar, and Concrete from St. Pancras.—The aqueous extract obtained from each of these by slow percolation had an alkaline reaction (alkalinity = from ·12 to ·13 gramme NaHO per 250 cubic centimetres of extract), and contained in each case compounds of sodium and potassium, the latter being present in moderately large proportion. T. E. THORPE.

March 21, 1895.

THE SELECT COMMITTEE ON TELEPHONY.

The Select Committee of the House of Commons appointed to enquire into the working of the telephone system resumed the hearing of evidence on Friday last.

Mr. Harcourt E. Clare, deputy town clerk of Liverpool and member of the council of the Association of Municipal Corporations, was called. He said that, together with the town clerk of Leeds, he had been asked to give evidence on behalf of the association. Their view was that the telephonic system was now an absolute commercial necessity, as well as a great convenience for private and domestic purposes. It was most important that the communication between the large centres of population should be made as cheap and as easy as possible. This was much more important than the development of the telephone system within any given area. The great proportion of the Stock Exchange business between Liverpool, Manchester, and London was done by telephone. The whole telephone system must be considered as a national undertaking, and ought not to be treated in each centre as a local matter. The view of the association was that the Government ought to take over the whole system, as the telephones had been declared to be a part of the Postmaster-General's monopoly. But if the Post Office and the Treasury thought that this was not advisable, of course they must look for some other solution of the question. The immediate effect of the Government taking over all the trunk lines, and those only, would be to cause delay in the intercommunication of local centres on account of the increased number of connections. But this undoubtedly could be remedied by increasing the number of trunk lines, and if the Government were prepared to do that to a greater extent than the company, then the public would benefit from the Government's acquisition of the trunk lines. But from the terms of the agreement between the Postmaster-General and the company he could not see how the public were to get any reduction of charges or increase of facilities unless there were a great extension of the trunk lines. If the Government did not take over the whole telephone system there was only one course to be followed, and that was to place all local exchanges under the control of one body, such as the National Telephone Company. It would be a national evil if any local area was allowed to separate itself from the rest of the country. He expressed the opinion of the entire Association of Municipal Corporations when he said that the municipalisation of local exchanges was impracticable and wrong in principle. Competition in telephones within any area could only result in increased expenditure He was strongly of opinion that the rates ought not to be pledged for the establishment of a trading concern, such as the telephone, which might prove to be a loss. The telephone was chiefly for the convenience of capitalists and well-to-do people—it was not for the benefit of the people at large, like gas and water ; and therefore he thought that the municipalisation of the telephones would be a very great mistake. The association which he represented practically included all the municipal corporations of the country, with the exception of the London Corporation. The telephone service would never be as cheap as it ought to be so long as the telephone companies had to work under a license terminating in 16 years, and under conditions which did not authorise them to maintain their undertakings. Their systems were constructed and maintained merely on sufferance. They had really no right to exist. Consequently they had to pay heavy charges for way-leave and other charges, somewhat in the nature

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of blackmail, to persons who had them "in a tight place." The companies ought to have, if the Government did not take over the whole system, the power to maintain their undertakings in a proper way and to utilise the streets for laying their lines, subject to the control of the corporations. He thought that a parliamentary committee should be appointed to enquire, not only into what powers should be given to the telephone companies, but also into what restrictions and conditions should be imposed as a return for the concession of the powers.

The **Chairman**: Such an enquiry comes strictly within the terms of reference to this committee.

Witness, continuing, said that as to the powers to be conferred possibly the powers possessed by the Postmaster-General under the Telegraph Acts might be all that were necessary, subject to some slight modification. As to the utilisation of the streets, the corporation of each town ought to be left absolute discretion as to whether the wires were to be laid underground or overhead; if underground, the corporation should have the right to lay the wires themselves for the company, charging the company with the cost. At present all the corporations had agreed to withhold their consent, under the Act of 1892, to the use of the streets for the telephones until an Act of Parliament was passed enabling them to impose the necessary restrictions on the telephone companies. Having fixed the powers which it was desirable to confer on the companies, the next point was the restrictions to be imposed. He suggested that the first should be a fair maximum dividend fixed on the capital of the company, having regard to the amount of it represented by their works. It might appear that a large portion of the capital was not such as the public ought to be called to pay a dividend upon. Next, maximum charges should be fixed. In the agreement with the Postmaster-General the whole country was divided into exchange areas. These might be classified and maximum charges fixed for each. There should be accompanying provisions to prevent the companies from unfairly favouring one exchange area at the expense of another, or one subscriber over another, where the circumstances were exactly the same. Further, the telephone subscribers being mostly well-to-do people, it might be well to consider whether the use of the telephones could not be extended by the establishment of call-offices which could be used for a small fee by those who could not afford to be on the exchanges.

The **Chairman**: What considerations do you propose to offer for the imposition of these restrictions on companies which have at present an unrestricted license?—**Witness**: You would give the companies extended powers of maintaining their undertakings; and the term of the licenses would be abolished, placing the companies in the same position as the gas and water companies, subject to provisions safeguarding the public from an oppressive monopoly. The Government should retain the power to acquire the whole telephone system upon fair terms and after reasonable notice, to be given at certain dates fixed by Act of Parliament.

The **Chairman**: The committee of 1892 reported strongly against the extension of the existing licenses.—**Witness**: The corporations did not appear before that committee; and it stands to reason that when the company is working under a license which practically ends their undertaking in 16 years they cannot develop their system or work it as cheaply as if they had a permanent existence. They must put by out of their revenue a large reserve fund, and this comes out of the subscribers' pockets. What the corporations want is that the Postmaster-General or some company should supply a telephone service of the best and cheapest kind, and we do not want to pay, as we do now, high prices for an unworkable system. As a matter of policy, witness said, he thought it was a great mistake on the part of the Postmaster-General ever to have farmed out any part of his monopoly. The purchase of the telegraphs was pressed on the Government in order to secure uniformity, and he would apply the same principle to the telephone system. Competition between the company and a corporation might, no doubt, lead to serious loss, not only to the corporation but also to the company, and any loss by the company in one area would have to be made up in another. If the Corporation of Glasgow wanted a system of their own, he did not see how Liverpool could interfere. He had never heard of any English corporation asking for or desiring a license.

Mr. John Harrison, town clerk of Leeds, said that speaking generally, he agreed with what Mr. Clare had said with regard to the municipalisation of telephones, though he was not authorised to speak on behalf of his Corporation. The best course of all would be, in his opinion, for the Government to take over the telephones. Failing that, one strong company should work them, with the exception of the trunk wires, under severe obligations and conditions. He would scarcely agree that the corporations were not in favour of competition, but if competition were allowed such persons connected with corporations as he had spoken to would be in favour of allowing corporations to join in the competition if they desired to do so.

Mr. W. H. Dickinson, deputy-chairman of the London County Council, said that the opinion of the committee of the Council which had been dealing with this question was that the operation of the agreement would very greatly strengthen the position of the telephone company, and would practically give them a monopoly for the whole kingdom.

The **Chairman** pointed out that no evidence against the policy of the agreement could be received. The only question that could be dealt with was the sufficiency of the telephone service throughout the country.

Mr. Benn urged that this was a very important matter, and, a discussion arising, the room was ordered to be cleared.

On the reopening of the doors it was announced that the committee had adjourned until April 26.—*The Times.*

LEGAL INTELLIGENCE.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

Judgment was delivered on Friday in this case, which was argued last month before Lord Halsbury and Lords Justices Lindley and Smith. The appeal was from the decision of Mr. Justice Kekewich, who held that the plaintiff and the mortgage debenture-holders whom he represented were not entitled to an order for sale or to the appointment of a manager, although the Company was in default. The Company was formed in 1883 and reconstructed in 1889, and its debenture debt amounted to £50,000. Mr. Justice Kekewich substantially held that a tram company must be treated as a railway company, which is by statute exempt from the operation, in case of default, of the provisions of the Companies' Act, 1862. Their Lordships confirmed that view, and dismissed the appeal with costs.

THE CASSEL GOLD EXTRACTING CASE.

In the Court of Appeal, on Tuesday, Lord Justice Smith delivered the considered judgment of the Court in the matter of the appeal from the judgment of Mr. Justice Romer, in the action of the Cassel Gold Extracting Company *v.* the Cyanide Gold Recovery Syndicate, Limited. The action was brought for the infringement of patent rights for a process for treating gold in crushed ore, and for recovering gold from tailings by the process known as the cyanide process. The defendants did not at the trial deny infringement if the patent was good; but they attacked the plaintiffs' patent, and Mr. Justice Romer held that it had been anticipated, and was consequently invalid. Against that decision the plaintiff company appealed, and the appeal was argued during several days in February last.

Lord Justice Smith, after describing the nature of the invention, by means of which in South Africa in 1893 no less than 500,000oz. of gold had been recovered, said the defendants did not deny the utility of the invention, nor did they deny that, if the patent was valid, they were infringers, but they denied the validity of the patent—first, on the ground that the process was old and well known to chemists and others at the date of the patent; and, secondly, that the patent was bad because the specification was too wide. It was proved that for many years prior to the date of the patent it was common knowledge that cyanide of potassium would extract gold in a finely divided condition. There was no doubt about that. This fact was contained in a paper read by Prof. Faraday in 1840, and there were patents taken out by Ray and Simpson, who obtained gold in solution, and then extracted it by means of electricity. After minutely describing these patented processes, his Lordship said the defendants failed to prove that they were able to treat gold in crushed ore and in tailings so as to give any good commercial results. As to the state of knowledge prior to the date of the plaintiffs' patent, the evidence showed that it was not known to Prof. Dewar, Prof. Crookes, Sir Henry Roscoe, Lord Kelvin, and other experts that a diluted cyanide of potassium had a selective action, and would treat gold before touching the baser metals, whilst a strong solution treated the gold and silver and baser metals at one and the same time. There was novelty and utility in the plaintiffs' invention, and in this respect their lordships differed from Mr. Justice Romer. But on the specifications—the provisional and final—their Lordships came to the conclusion that there was disconformity between them, and that the two specifications could not be read as having the same meaning. The provisional was a claim for all solutions of cyanide of potassium, and the final was for a dilute solution. Sir Richard Webster urged that they were one and the same thing, but their Lordships held that the first claim was for any solution of cyanide independent of its strength, and this claim being too wide there must be a judgment for the defendants.

The appeal of the plaintiff company was therefore dismissed with costs.

A QUESTION OF SHARE TRANSFERS.

In the matter of the New Zealand Electrical Syndicate, Limited, **Mr. Leigh Clare** on Tuesday asked Mr. Justice Kekewich, on behalf of Mr. C. F. Kemp, to direct that certain shares be registered in the books of the company, so as to vest those shares in him as the voluntary liquidator of the Gulcher Company. The shares, which were £10 fully paid, were standing in the name of one, Pryor, as trustee for the Gulcher Company, and he transferred them, with other shares, to Messrs. H. R. Savory and Frederick Williams, in order to qualify them as directors of the New Zealand Syndicate, who, however, refused them registration. It was said there was some arrangement between the syndicate and the Gas and Water and General Investment Trust, Limited, by which the latter were entitled to three directors on the New Zealand Board, and that the shares in question were transferred by Pryor to Savory and Williams to qualify them for such directorate. The Gas and Water Trust had served notice that they intended to oppose these shares being transferred as was now asked.

Mr. Bramwell Davis, Q.C., now appearing in support of that notice, his Lordship, without proceeding further, adjourned the application to enable the notice of motion to be amended.

Western and Brazilian Telegraph Company.—The receipts for the past week were £3,116.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Manchester.—The Lancashire and Yorkshire Railway Company require by the 30th April tenders for the supply of an oil-engine engine packing, signal and telegraph fittings, signal, telegraph and electric light wires, wire, etc.

Stowmarket.—The Urban District Council require by April 15 tenders for lighting the streets of Stowmarket from August 15 next to May 15, 1896, and also for lighting the post office clock. Particulars may be had of Mr. S. Prentice, clerk.

South Shields.—Tenders are invited for the supply and erection of a 10-ton hand-power overhead travelling crane at the Corporation electricity works. Copies of specification, including form of tender and general conditions, can be obtained at the borough electrical engineer's office, Waterloo-vale, South Shields, on and after 8th inst. Tenders, sealed, and marked "Tender for Crane," to be delivered to Mr. J. Moore Hayton, town clerk, Court Buildings, South Shields, by 10 a m. on 22nd inst.

Rangoon.—Tenders will be received by the president of the Rangoon Municipal Committee, not later than November 4, for the lighting of Rangoon by electricity. Tenders should be accompanied by detailed plans, specifications, and estimates, and must state the terms on which the installation proposed will be undertaken. All information regarding the existing system of lighting and the cost, etc., with plan of the town, can be obtained on application to Messrs. Ogilvy, Gillanders, and Co., Sun-court, 67, Cornhill, London, E.C., accompanied by a remittance of £1. 1s. Tenders are to be sent in sealed covers and endorsed "Tender for Electric Lighting, Rangoon." Mr. J. Short, Rangoon, is the secretary of the committee.

Brighton.—The Town Council invite tenders for the extension of the Corporation electricity generating station, North-road, comprising engine-room, boiler-house, coal stores, chimney shaft, and other works in connection therewith, for the Town Council. Drawings may be seen at the office of the borough engineer and surveyor, Mr. Francis J. C. May, M I C.E., Town Hall, Brighton, where specification, bills of quantities, and forms of tender can be obtained after 10th inst. upon the payment of £5. 5s., which sum will be returned on the receipt of a *bonâ fide* tender. Sealed tenders, addressed to Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton, and endorsed "Tender for Extension of Corporation Electricity Station," must be left at the town clerk's office before 10 a m. on 25th inst.

Birkenhead.—The Corporation invite tenders for the erection and completion of a brick chimney 124ft. high above concrete bed, and for the construction of the necessary foundations thereof, in connection with the electric light station. Plans, specifications, and particulars, with form of contract, can be seen, and (upon deposit of the sum of £1. 1s., which will be repaid upon receipt by the Corporation of a *bonâ fide* tender) bills of quantities, with form of tender, can be obtained, on application at the town clerk's office, Town Hall, Birkenhead, or at the office of Mr. James N. Shoolbred, M.I.C.E, Albany-buildings, 47, Victoria-street, London, S.W. Tenders, which must be on the prescribed form, sealed and endorsed "Tender for Erection of Chimney," must reach Mr. Alfred Gill, town clerk, Town Hall, Birkenhead, by 12 noon on 22nd inst.

RESULTS OF TENDERS.

Brighton.—The Town Council have accepted the offer of Messrs. Crompton and Co., Limited, to supply two new armatures for the steam dynamos for the sum of £426.

York.—The tender of Messrs. Scott and Mountain has been accepted for providing an engine and dynamo for an electric light installation at the new sewage works at Fulford, for the City Council, at £157. 10s.

Bradford.—The Town Council have accepted the tender of Messrs. Siemens Bros. and Co., Limited, for supplying and fixing at the electricity works two 300-h p. engines each coupled with a Siemens dynamo, for £3,980.

South Shields.—At the Council meeting held on the 3rd inst. the tender of Mr. W. H. Brown, amounting to £3,124. 15s., for erecting the buildings in connection with the central station was accepted. The buildings have been designed and the specification for the work prepared by Mr. Jeckell, the borough electrical engineer, whose original estimate for the work was £3,100. Mr. Fred Rennoldson, South Shields, prepared the bills of quantities for the contractors.

Appointment Vacant.—A working foreman engineer is required for the London County Asylum, Claybury, Woodford, Essex, to take charge under the asylum's engineer of the whole of the engineering appliances, which include the heating system, electric light installation, laundry machinery, and cooking apparatus. He must be a thorough mechanic, able to control men, and with some experience of electric light plant. Salary £156 per annum, with house, coal, and gas. Persons desirous of applying must write, enclosing a stamped envelope, to Mr. R. W. Partridge, clerk of the Asylums Committee, 21, Whitehall-place, S.W., for an application form, upon which the conditions of service and other particulars will be stated. All applications must be delivered by 9 a.m. on 22nd inst.

BUSINESS NOTES.

Aberdeen.—Mr. A. S. Blackburn has written to the Town Council accepting the appointment of electrical engineer.

Dewsbury.—A meeting of the Town Council was held on Tuesday, at which it was agreed that the new baths and library be fitted throughout for electric lighting.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 7th inst. amounted to £1 024, as compared with £691 in the corresponding week of last year.

Halifax.—The Town Council have decided that application be made to borrow £5,000 to complete the original scheme of electric lighting, and £5,000 for additional electric lighting plant and extensions.

Hastings.—A new transformer-chamber is to be constructed under the public pavement at the junction of Norman road and London-road by the Hastings and St. Leonards-on-Sea Electric Light Company.

Burton.—The Gas and Electric Lighting Committee of the Town Council have recommended that the electric lighting main should be extended to Ashby-road and Alexandra-road, and the recommendation has been agreed to.

Northampton.—It was stated at a meeting of the Town Council that the electric light company had been requested to send in an estimate for four lights to be placed in the Market-square, but that they had not yet sent the estimate.

Anglo-American Telegraph Company.—The directors have declared quarterly interim dividends of ½ per cent. on the ordinary stock and of 1 per cent. on the preferred stock. The sum of £6,000 is to be transferred to the renewal fund.

The Britannia Company.—This Company are now opening an electrical department at 100, Houndsditch, E.C., in connection with their Colchester works, for all kinds of electrical work, more especially for electric lighting and transmission of power.

Indo-European Telegraph Company.—The directors recommend a balance dividend of 17s. 6d. per share and a bonus of 20s. per share, making a total of 10 per cent. for the year ended December 1 last. The sum of £10 000 is to be placed to the reserve fund.

Great Northern Telegraph Company of Copenhagen.—A final dividend of 7s. 2d. per share is recommended by the Board for the year 1894 together with the addition of £83,333 to the reserve and renewal fund, leaving £43,170 to the credit of the current year.

Eastbourne.—At the last meeting of the Town Council it was ordered that the common seal be fixed to the agreement between the Eastbourne Electric Light Company and the Corporation as to the laying of electric light wires, mains, boxes, etc., in the public footpaths in the borough.

Liverpool.—A meeting of the Special Lighting Committee of the Corporation was held on Monday, at which there was a discussion regarding the terms to be offered for the purchase of the electric supply company. It is understood that the sum of £400,000 was mentioned as the price to be offered.

Epstein Accumulators—The contracts for the central-station batteries for the Kensington and Knightsbridge Electric Lighting Company, Limited, at Kensington Court, and for the National Electric Supply Company, Limited, at Preston, have been placed with the Epstein Electric Accumulator Company.

City and South London Railway.—The receipts of the Company for the week ended April 7 were £935, against £852 for the corresponding week of 1894, or an increase of £83. The total receipts for the current period of the present half-year are £13,583 against £12,887 in the corresponding period of 1894, an increase of £696

Littlehampton.—Mr. Henry Harben, of Hampstead, who has taken great interest in the North-West London Convalescent Homes fund for working-men, has decided to erect at his own expense a building at Littlehampton, to cost £20,000. The home will be lighted throughout by electricity. The work is to be put in hand forthwith.

Brighton.—The Lighting Committee of the Town Council have resolved to offer the receiver and liquidator of Messrs. Latimer Clark, Muirhead, and Co., Limited, £1,000 in settlement of all claims under the contract of that firm. The committee have also adopted rules for the admittance of visitors to the electricity generating station.

Ayr.—The Town Council met on Monday, when Mr. Hammond reported that satisfactory progress was being made with the electric lighting works, and that the cable had been laid in Mill-street and High-street. It was remitted to a committee, with powers, to get the light introduced into the Town Hall and the other principal town buildings.

Removal.—Messrs. H. M. Salmony and Co. inform us that they have removed from their temporary offices at 66, Basinghall-street, E.C., to premises at 61, Charing Cross-road, W.C. They have also taken extensive warehouses at Sandringham-buildings, Charing Cross-road, where they will keep a large stock of all kinds of electrical accessories. The firm are still manufacturing at Notting Hill as hitherto.

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Shop-Lighting.—The business premises of Mr. H. Chadwick, clothier, etc., Westgate, Dewsbury, have just been lighted electrically. Mr. A. Richmond Turner, electrician, of Bradford-road, carried out the work. Messrs. Chadwick and Son have six arc lamps of 1,000 c.p. each—two outside to light the windows and four inside—also four 16-c.p. incandescent lamps. They are supplied with current from the Dewsbury Corporation mains.

Hull.—At a meeting of the Hull Town Council on the 4th inst., Dr. Holder, moving the adoption of the committee's minutes, urged that that portion recommending that specifications for the new engine, dynamo, boiler, and switches, instruments, etc., and that quotations be obtained, be approved. Several members spoke strongly in favour of keeping the work in the town, and it was suggested that tenders should be invited from local firms for such portions of the work as could be done in Hull.

Enlargement of Premises.—Messrs. Green and Treacher, manufacturing electricians and electrical engineers, of 77, Cannon-street, E.C., inform us that, owing to the increased demands for their manufactures, they are enlarging their premises at 77, Cannon-street with the view of holding a more varied stock to meet the requirements of their wholesale and retail customers, and that they will stock all materials for electric bell and telephone work, and also small and general fittings used on electric lighting.

Cheltenham.—At the last meeting of the Town Council it was stated by Mr. Norman that he hoped that during this week or the next the Council might be invited to see the machinery at the electric light station in motion. At the expiration of a month from the present time the Council would take over the works from the contractors, and then an opportunity would be afforded for the public to visit the station, which, so far as machinery and equipment were concerned, was equal to any in the country.

Llanrwst.—The question of laying down an electric tramway from Trefriw to Llanrwst Station came before the Board of Guardians at its last meeting. The chairman said that the committee appointed to meet the promoters had seen them; but Mr. Bircham (Local Government Board inspector) had been to see the ground, and had given the committee to understand that he was opposed to the project, and there had been no further discussion of the matter. Mr. Bircham attended, and explained his objections. No decision was arrived at.

Bangor (Ireland).—The Town Commissioners of Bangor have received a letter from the secretary of the electrical works, Belfast, stating he had learned that the Commissioners proposed to light the promenade with electricity. He would be glad to tender for the supply and erection of the entire plant, which, consisting of 12 lamps of 2,000 c.p. each, with gas-engine, dynamo, and everything erected complete, would cost about £500. The cost of running the lights would not be more than 1s 6d per hour and 250ft. of gas for engine.

Rand Central Electric Works, Limited.—This Company has been registered, with a capital of £300,000, to carry on the business of generators and distributors of electric energy for the purposes of light, heat, motive power, or otherwise, at the Witwatersrand, and elsewhere in South Africa; to supply electric energy to the mines and other properties situate in or near to the Witwatersrand and elsewhere; for the above purposes to enter into and carry into effect two agreements expressed to be made by this Company with Messrs Siemens and Halske, of Berlin, and to carry on the business of an electric light and power company in all its branches

Worcester.—At the last meeting of the City Council a resolution was adopted empowering the Electricity Committee from time to time to employ such staff for the electricity installation as they might find necessary. It was stated that the committee at present proposed to employ three electricians (at £110, £90, and £65 a year respectively), two juniors to take charge of the switchboards (at £39 each), three drivers (at £83. 4s. each), two firemen (at £72. 16s. each), and two labourers (at £63. 14s. each)—a total cost of £865. 12s. per annum. The staff would have to work 24 hours every day, and would consist of three shifts of men. This would be exclusive of Mr. Murray's salary of £250 as manager of the works.

Kidderminster.—At the last meeting of the Town Council the Improvement Committee reported a communication from Messrs. A. Dickinson and Co., consulting engineers, Colmore-row, Birmingham, to the effect that they had clients who were prepared to promote a provisional order for the construction of an electric tramway from Kidderminster to Stourport, commencing at the top of Comberton Hill, Kidderminster, and ending at the Swan, Stourport, and asking for the approval of the Council. The committee recommended that the town clerk be instructed to reply that, subject to the rights and interests of the Town Council being properly protected, they were disposed to give the scheme their favourable consideration.

Llandrindod Wells.—At the last meeting of the Urban District Council correspondence was read on the subject of the introduction of the electric light, from which it appeared that Messrs. Andrews and Preece, Bradford, who at one time were prepared to take the matter up, were now too busily engaged elsewhere to do so, but suggested Mr. E. Blakey as a competent electrician. It was decided that advertisements should be inserted in the electrical newspapers inviting firms who were disposed to take the matter up to communicate with the Council. It was considered advisable that the Council should obtain a provisional order to authorise electric lighting, and then make arrangements with a private company to carry out the scheme.

Plymouth.—The committee appointed to enquire into the working of electric light systems in other towns have prepared a detailed report of their investigations decidedly favourable to the introduction of the light into Plymouth. They, however, think that before the Town Council come to any decision in the matter, it would be desirable for a sub-committee to visit other large and successful installations in London and the provinces, and bring up a further report for the guidance of the Council. The Council at their last meeting, on the suggestion of the Town Clerk, decided that the consideration of the report of the Electric Lighting Sub-Committee be adjourned, and that the matter be referred back to the committee, with instructions to employ an expert, and obtain and present a full report as to the best method of proceeding and probable expense.

Southport.—Mr. Rienzi Walton has held an enquiry on behalf of the Local Government Board with regard to an application by the Town Council relating to the electric lighting system, which was put into operation last November. The present borrowing powers amounted to £28,000, of which they have already expended £18,746, leaving a balance of £9,254. Already more than 2 000 lamps are wired on the mains more than the generating plant could really supply, and the Electric Lighting Committee propose to extend the buildings and power of the station to meet the present growing demand, and to enable them to tap the residential district of Hesketh Park. The cost of this work is estimated at £21.250, and over and above the balance in hand they applied for power to borrow £12,000, in addition to £3,500 for street-lighting, making £15,500 There was no opposition to the application.

Acton.—Mr. T. Baker, of Leamington-park, has written to the Urban District Council offering to assist the Council by drawing up gratuitously a report on the probable cost of a public installation of electricity and the returns which might be expected if he were furnished with certain data. At the same meeting a letter was read from Messrs New and Mayne accepting the Council's terms for the transfer to them of the Council's electric lighting order, but suggesting that if the Council decided to adopt the proposed sliding scale a minimum price of £2. 10s. per lamp should be fixed. The chairman remarked that if a minimum price were fixed a maximum must also be decided upon. Mr. Poulton observed that he was sorry that Messrs. New and Mayne had accepted the Council's terms. After a long discussion it was decided not to agree to Messrs. New and Mayne's proposal as to fixing a minimum price, and to ask them to say definitely whether they would accept the Council's terms.

Eccles.—The Town Hall and Electric Lighting Committee reported to the Town Council meeting that they had resolved that Mr. S. V. Clirehugh should be offered the appointment of consulting electrical engineer to the Corporation, for the purpose of the preparation of a detailed scheme for electric lighting in the borough according to the directions of the committee; to get out the requisite plans, specifications, and quantities, and estimates of cost, upon which borrowing powers could be applied for and tenders obtained for carrying out the work; and to supervise the work if it should be carried out, providing the committee were at liberty, if they saw reason, to determine the engagement at any time. The committee also asked that they might be authorised to visit the electric light stations at Manchester, Altrincham, Wolverhampton, Reading, Kingston-upon-Thames, Ealing, Woking, and St. Pancras to inspect the works. After discussion as to the number of places to be inspected, the report of the committee was adopted, on the understanding that the first three places mentioned only were to be visited.

Dover.—The sub-committee reported to the Town Council at their last meeting that Mr. Whitlock, of the Dover Electricity Supply Company, had enquired which 10 of the 21 arc lamps the Council wished to remain alight all night, and it was agreed that the matter should be referred to the Castle and Town Ward Lighting Committee. The Deputy Town Clerk stated that they had not yet received a reply from the Board of Trade in respect of their request that an inspector should be sent down to test the wires and fittings. The Chairman said that he thought the Board of Trade would reply that they had no itinerant inspector, and then their next duty would be themselves to appoint an expert to inspect the works, dynamos, and everything appertaining to the installation of the light. He thought that it would be their duty, as much for the interests of the ratepayers as the company, to see that there was no risk of accident. He thought the Board of Trade was bound to appoint an expert to give them a certificate as to the work and as to its efficiency or non-efficiency. They had specially contracted themselves as undertakers, and had this power.

Salisbury.—The Town Council have received a report from the Electric Light Committee, in which they state that they have received a communication from the Board of Trade in reference to the application by the Salisbury Electric Light and Supply Company, Limited, for the consent of that authority to the grant to the company of a provisional order to supply the city with electric light. The proposed provisional order was considered and compared with the license issued to the company by the Board of Trade on December 6, 1894. The committee resolved to recommend the sanitary authority to offer no objections to the issue by the Board of Trade of the proposed provisional order, save that such Board be urged to insert therein the whole of clause 19 incorporated in the license, as also such portions of clause 20 as could be made applicable to a provisional order; further, that the Board of Trade be solicited to insert in the provisional order such words as they might deem desirable with a view to providing, as far as might be, against the danger arising from the accumulation of gas

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in street boxes and the escape of current, as evidenced by accidents which had from time to time happened in London and elsewhere. The report was adopted.

Edinburgh.—The current for the electric lighting of Edinburgh was to be turned on last night at eight o'clock by Mrs. M'Donald, wife of the Lord Provost, and Princes-street was to be instantaneously illuminated. Arrangements were made to allow of the ceremony being performed in the Rutland Hotel, the necessary connection having been provided by a wire taken into the building. At the last meeting of the Town Council it was recommended that the special attention of the Gas Commissioners should be called to the matter of faulty gas-mains and service-pipes in view of the introduction of the electric light. Councillor Mackenzie remarked that the officials of the gas managers should not look for leaks with naked lights, as he understood they had been doing. The Electric Lighting Committee, however, were not under any apprehension in regard to the matter at all, as every precaution was being taken. Bailie Anderson thought this motion was a gratuitous censure on the Gas Commission, and an instruction as to how the men were to do their duty. As it was, the Commission had been very much concerned about the laying of the electric mains, and had been put to a great deal of trouble and expense owing to injuries done to their gas-mains. After some discussion the report was adopted.

Tunbridge Wells.—The Lighting Committee have reported to the Town Council that the electric light would very soon be ready for use. Alderman Delves wished to know how the town was to be lighted after midnight, if the light was to be extinguished at 12 o'clock. Councillor Wood, as chairman of the committee, said if the light were put out at midnight the cost would be about £10 or £12 per year per lamp, but if the light were kept in till the early hours of the morning the expense would be from £20 to £25 per lamp per year. Councillor Gower having pointed out the need of extra light in the Camden-road district, the report was adopted. On subsequent proceedings of the committee coming up for confirmation, Mr. Stone Wigg drew attention to the position of the arc lamp at the South-Eastern Railway bridge, High-street. He said in its present position it was an obstruction to traffic, and he moved that it be placed in a different place. Councillor Grover seconded the motion. Councillor Wood said the committee considered the position the best that could be obtained when they erected the lamp, but they would again consider the matter. With regard to the cost of lighting the streets by electricity, he said he could assure them that when the latter was laid on they would get ten times the light for the same money that they were now paying for gas. He likewise mentioned that the committee would consider fairly the request that had been made by inhabitants in Camden-road to have lamps erected there. The report was adopted.

Newington, S.E.—At the last meeting of the Vestry the clerk read a long report with regard to electric lighting. The General Purposes and Lighting Committee urged that the Vestry should obtain a provisional order, and thus prevent a company obtaining a monopoly for 42 years. The committee recommended, "That the provisional order promoted by the County of London and Brush Provincial Electric Lighting Company, Limited, be opposed, by the Vestry giving an undertaking to the Board of Trade to promote a provisional order in the next session of Parliament for supplying a competitive supply in the parish to that undertaken by the London Electric Supply Corporation." Mr. Smithers supported the recommendation. He said the provisional order would cost only about £200. After the order had been obtained there was no need for the Vestry to proceed under two years, and the Vestry elections would enable the ratepayers to express their opinions on electric lighting in the parish. Mr. Parker, L.C.C., said he should be very happy to support the proposal that the London County Council should grant a lengthy period for the repayment of loans raised for the purposes of electric lighting. He thought the Vestry should not allow a company to get a monopoly. At the same time they should take care before they went into a large scheme for electric lighting. He did not see why a vestry could not make electric lighting pay as well as a private company. After some further discussion, in which several members spoke of the advantages of electric lighting, the recommendation of the committee was unanimously adopted.

Newport (Mon.).—A meeting of the Town Council was held on Tuesday, at which a good deal of discussion took place on the electric lighting of the town. The sub-committee in charge of the matter recommended the staff necessary for the smooth running of the works. It was suggested that there be a works manager at, say, £180 per annum, an assistant manager at, say, £130, and mechanics for the night-load plant and others for the day-load plant. The salary suggested for the works manager at £180 was fixed upon the assumption that the installation would be worked to some extent under the supervision of the borough engineer, otherwise a more expensive man would be necessary. The total salaries proposed amounted to £950 per annum. Mr. Fred Phillips thought the salary of the general manager should be raised and the salary of the assistant lowered. Mr. R. Wilkinson said he had a protest of ratepayers in the shape of a memorial, numerously signed, against the expenditure of the Corporation. Touching the electric light, it pointed out that a sum of £229 odd had been spent in the travelling expenses of deputations. Mr. Mordey said the Council had that day passed a scale for the expenses of deputations—viz., first-class travelling and a guinea and a half per day. Alderman Moses (chair of the Electric Lighting Sub-Committee) said they had heard a good deal from the croakers and the prophets of evil, who had no other desire than to see the installation a failure, but up to the present there had been no failure whatever in any of the plant, but, on the contrary, everything had been a great success. The Corporation had so far had applications for 2,000 8-c.p. lights, exclusive of the lighting of public buildings. The Corporation could not supply all the premises wired, because the wiring had not been carried out in accordance with the by-laws of the Corporation. As to the final completion of the works—for street-lighting as well as private lighting—he thought it might take place in two months, but he could not say definitely. But they would not run the large engines until they were thoroughly satisfied that they were in proper order.

Rochdale.—At the monthly meeting of the Town Council it was stated in the minutes of the General Purposes Committee that the sub-committee which had been appointed to consider the question of lighting the Town Hall, free public library, technical school, and other public buildings by electricity had recommended, on account of the heavy cost of lighting the Town Hall by electricity compared with the present cost, and the undesirableness of undertaking piecemeal installations, the postponement of any electric lighting until the Corporation determined upon a general scheme for lighting a section of the town. The General Purposes Committee had approved of the recommendation. Alderman T. Schofield, chairman of the committee, in answer to questions, said that the Corporation would not be able to bring the electric light from the sanitary works without first obtaining a provisional order from the Government, and in such a case they would have to state what area they intended to cover, and when they had got such an order they would be compelled to supply any tradesman who applied for a supply. The sanitary works were about three-quarters of a mile from the Town Hall, and they could imagine the expense that would have to be incurred if they decided to adopt the electric light. The cost of lighting the Town Hall would be two or three times greater than at present. It would be cheaper to provide an installation in the Town Hall itself. Again, the sanitary works were not situated in the centre of Rochdale, and it would be better to postpone any electric lighting until they determined upon a general scheme. Mr. Diggle said he was not satisfied with the report. He was confident that the extra power at their sanitary works could be utilised in lighting their public buildings by electricity. He moved that the Health Committee be requested to report at what price they could supply the electric light for their public buildings. Alderman W. J. Petrie, chairman of the Gas Committee, said he was very much in favour of electric lighting. After other members had expressed opinions on the subject, the amendment was lost, and the minutes of the General Purposes Committee were confirmed.

Dublin.—A deputation from the Dublin United Tramways Company waited upon the Pembroke Township Commissioners at their last meeting with reference to the proposal to use electric traction for their tramway system. Dr. Carte, chairman of the company, in introducing the deputation, said they felt confident of the Board's friendly interest in the company. Different systems of electrical traction for trams were in operation in different parts of the world. During last autumn a deputation from the company went to the Continent, and on visiting the principal places where electricity was used for trams they found that the overhead system was one of the most popular and useful. They therefore decided to apply this system on their trams and hoped to get the sanction of Parliament and the Commissioners for it. This overhead system would cause less obstruction of traffic than any other system, and the cleanliness of the streets would be much greater than with the horse traffic. In addition, it would give the public a more rapid service than at present, and would facilitate the public and benefit the township. At present the company only proposed to obtain electric traction for their lines from Nelson's Pillar to Clontarf, but they would afterwards introduce it on their other lines. The Commissioners had already given their sanction to an English company to work their trams to Dalkey by electricity, and the Dublin United Tramway Company would meet those trams and carry it to Dublin. Without their help the system referred to would not be effective. There was great competition from the railways, and he thought they should bring as much traffic into the township by giving the facilities which they asked for. The obstruction would be very trifling, especially in this township, where there was a straight line of road, and no curves or narrow streets. Mr. J. R. Wigham, a director of the company, said he was familiar with the application of electricity, and had very strong opinions on the overhead or trolley system as being the best devised for the propulsion of tramcars. By this system the cars were under most perfect control—more so than with horses. In reply to the chairman, Dr. Carte said they proposed to light the cars with electricity. The Chairman said the Commissioners were not yet in a position to give the deputation an answer to their application. They felt a great deal of anxiety to see how the system at present being constructed in the township would be carried on. The deputation then withdrew.

Bristol.—The following report dealing with the progress of electric lighting in Bristol has been presented to the Town Council by the Electrical Committee: "Your committee report that, after careful consideration of the present position of the electric light undertaking, they have determined to recommend the Council to sanction a moderate extension of the system for supplying electric current for private lighting. The Council are aware that the capital embarked in the undertaking amounts to £90,000, consisting of £16,000, the borrowing of which was authorised on March 10, 1891, for establishing the installation, and of £24,000, the borrowing of which was authorised on December 12, 1893, partly for paying off liabilities incurred in excess of the sum of £66,000 and partly for extensions of the system for private supply. By means of this expenditure your committee have been enabled to provide machinery and plant capable of supplying 34,000 lamps,

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and to extend the system for private supply beyond the streets contemplated in the original scheme, to Guthrie-road, College-road, Clifton-park, Regent-street, Victoria-street, the Mall, and Portland-place, Clifton, and to Redcliff-hill. The number of lamps now supplied is 17,425, being only about one-half of the number which the existing plant is capable of supplying, and your committee consider that in order that the undertaking may become a source of profit to the Corporation every effort should be made to bring the output of electricity up to the full capacity of the plant, as the increase in revenue derived from the supply of current to additional lamps is largely in excess of the increase in the working expenses necessary to afford the supply. They also consider that it is important to obtain as customers the residents in private houses where artificial light is used during longer hours than in the case of shops. As the result of enquiries as to the localities from which the most profitable results may be expected, your committee have resolved to recommend the Council to extend the system for private supply to White Ladies'-road, Redland-park-road, Park row, Stoke's-croft, Clarence-road (St. Philip), and East-street (Bedminster) The electrical engineer estimates that the cost of laying mains in these streets, and providing the necessary apparatus, will amount to £8 000 and that £2,000 will be required, in addition, to connect new customers anticipated in streets in which mains are already provided. Your committee therefore recommend the Council to authorise them to arrange for borrowing the sum of £10,000 on the security of the district fund and general district rate."

PROVISIONAL PATENTS, 1895.

APRIL 1.

6622. **Improved mechanism for feeding the carbons in an electric arc lamp.** Archibald John Howard, Euston Villa, Cheddon-road, Taunton.

6630. **Improvements in automatic exchange systems and apparatus for telephonic and other electrical communication.** Ridley James Urquhart, 57, Barton-arcade, Manchester. (Ward Decker, United States.)

6649. **A system in connection with electric burglar alarms and other apparatus to which it is applicable.** Frank Terrey, 76 Royal-road, Kennington, London.

6652. **Improvements in the construction of electric accumulator plates.** Arthur Duffek and Bohumil Holub, 8, Quality-court, Chancery-lane, London. (Complete specification.)

6654. **Improvements in telephone transmitters.** Maxymilian Kotyra, 24, Queen Victoria-street, London.

6657. **Improvements in holders for incandescence electric lamps for stage and like purposes** George Lyons and Henry Bevis, 73. St. Stephen's road, Upton Park, London.

6674. **Improvements in asynchronous alternating-current motors.** Gustav Benischke, 4, South-street, Finsbury, London.

6681. **Improvements in or relating to electric switches or circuit controllers.** John Mathew Cronin, 18, Buckingham-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, 22nd September, 1894, being date of application in the United States.) (Complete specification.)

APRIL 2.

6756. **An improved mode of connecting the parts of a telephone apparatus.** Alfred Julius Boult, 323, High Holborn, London. (Parnell Rabbidge, Australia) (Complete specification.)

6781. **A socket for electric glow lamps.** The Edison and Swan United Electric Light Company, Limited, and Charles Faraday Proctor, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6788. **Improvements in or connected with apparatus for recording and reproducing telephonic messages.** Robert Kirk Boyle, 4, South-street, Finsbury, London.

6791. **Improvements in and relating to dynamo-electric machinery.** P. R. Jackson and Co., Limited, Joseph Slater Lewis, and George Kemp, 31, High Holborn, London.

6795. **Improvements in enclosed electric mining switches.** P. R. Jackson and Co., Limited, and Joseph Slater Lewis, 31, High Holborn, London.

APRIL 3.

6893. **Improvements in electrical signalling apparatus for marine purposes.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Bradley Allan Fiske, United States.) (Complete specification.)

APRIL 4.

6908. **Improvements in electric weighing apparatus.** Henry Richardson, City Mill, Lichfield.

6934. **An improvement in electric glow lamps.** Henry William Handcock and Alfred Herbert Dykes, 5, Victoria-street, Westminster.

6935. **Improvements in and connected with junction-boxes for electric cables and the like.** Samuel George Dutton, 41A, Upper Manor-street, Chelsea, London.

6952. **A new or improved electrically opened and closed gas burner.** Eric Gustaf Rudén and Knut Leonard Norén, 18, Buckingham-street, Strand, London.

APRIL 5.

7009. **Improvements in dynamo-electric machines.** James Finlayson, 62, St. Vincent-street, Glasgow.

APRIL 6.

7075. **Improvements in and connected with electric cooking and heating grills and similar apparatus.** Thomas Fletcher, William Russell, and Fletcher, Russell, and Co., Limited, 70, Market-street, Manchester.

7086. **Automatic electric switch.** George William Russell, jun., and Alexander Vernon Officer, 52, Chancery-lane, London. (Complete specification.)

7107. **Improvements in working electric arc lamps and apparatus therefor.** James Brockie, 28, Southampton-buildings, Chancery lane, London.

7108. **Improvements in the purification of saccharine juices by electrolytic treatment, and means employed for that purpose.** Oliver Imray, 28 Southampton-buildings, Chancery-lane, London. (La Société Anonyme Raffinerie, Say, France. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1894.

5631. **Electric lighting of trains, etc.** Preston and Gill.

6046. **Electrolysis of saline solutions.** L. A. P. and H. E. A Liénard. (Second edition.)

6497. **Electrolysing chloride solutions.** Hermite and others.

8292. **Charging secondary batteries.** Liardet.

8350. **Electric batteries.** Leigh. (Vohwinkel.)

8972. **Secondary batteries.** Griffin.

10331. **Electric tram and rail vehicles.** Behr.

10515. **Dynamo brushes.** Fleming.

15403. **Telephones and microphones.** Krützfeldt.

1895.

1446. **Galvanic batteries.** Schoenmehl and Platt.

3095. **Electrical exchange systems.** Hey and Parsons.

3134. **Telephonic connections.** Hempel and Maerker.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅝-2⅞
—— Nom. Cum , 6 per cent. Pref.	2	2⅝-2⅞
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5-5½
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	14½-15½
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	130-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	100-105
Electric Construction, Limited	2	½-⅝
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1½-1¾
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1½-1¾
Elmore's French Company	2	—
Elmore's Wire Company	2	1½-1¾
Fowler-Waring Cables	5	⅝-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	9½-10½
—— Preference	—	12
House-to-House Company, Ordinary	5	3⅛ 4
—— 7 per cent. Preference	5	7½-7¾
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	6¾-7
—— Pref.	—	—
Liverpool Overhead Railway	10	8¾-8⅞
—— Pref.	10	13½-14
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	½-⅝
Metropolitan Electric Supply	10	10¼ 10⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5¼ 5½
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7¼ 7⅜
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7-7⅝
—— £4½ shares	4½	5¾-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7½-8
—— 7 per cent. Pref.	5	8½-9
Swan United	—	—
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Westminster Electric Supply, Ordinary	5	7½-8
Yorkshire House-to-House	5	5¼-5⅝

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NOTES.

Electric Traction in Brazil.—The *Jornal do Brazil* states that on Laderia de Santo Antonio work has been commenced on the Santa Theresa Electric Railway.

Healthy.—In his annual report, Dr. J. Clare, medical officer of Hanley, draws attention to the important fact, from a sanitary point of view, that the electricity works have been inaugurated during the year.

Electric Heating.—The non-technical papers are now taking up this subject. Thus *St. Paul's* of the 13th inst. contains an article by the Comtesse de Bremont on Messrs Crompton's electrical cooking and heating appliances.

Engineers' Tools.—The Britannia Company, of Colchester, send us a catalogue containing illustrated particulars of engineers', woodworkers', and amateurs' tools made by them. The company have likewise issued advertising 12in. and 9in. rules.

Robbery.—The premises of the Brush Electric Light Company, 49, Queen Victoria-street, were found broken open on Wednesday morning, and £300 is stated to be missing. It is believed duplicate or skeleton keys were used to effect an entrance.

Croydon County Polytechnic.—A special lecture was delivered at this institution last night (Thursday) by Mr. H. Byron Ransom, A.M.I.C.E., on "The Mechanical Principles of Electrical Engineering." A popular lecture will be given on Saturday next at the same place by Mr. A. Scholey on "The Applications of Electricity."

Books Received.—We have received from Messrs. Whittaker and Co., 2, White Hart-street, E.C., "Hydraulic Motors: Turbine and Pressure Engines," for the use of engineers, manufacturers, and students, by Mr. G. R. Bodmer, A.M.I.C.E. (second edition), and "The Steam Jacket," by Mr. William Fletcher (second edition).

Birmingham Technical School.—A new technical school in Suffolk-street, Birmingham, is approaching completion. On the first floor is the physics department, with a large lecture-room adjoining, the chemistry lecture-room, and the electrical engineering and telegraphic laboratories, the dynamo-room, and an apartment for applied physics.

Engineer Volunteers.—During the Easter Volunteer manœuvres, one of the works carried out at Chatham by the East London was a wire entanglement just in front of which a series of small mines were contrived, so connected by electricity that the whole would be exploded at once by the first enemy whose foot got entangled in or tripped over a wire.

Comparisons are "Odorous."—A meeting of the Cleaning and Lighting Committee of the Edinburgh Town Council has been held, at which it was resolved to recommend that in future none of the street gas lamps should be turned out at midnight in order to make the contrast between the gas-lighted and electric-lighted portions of the city less conspicuous.

Institution of Electrical Engineers.—The next meeting will be held at the Society of Arts, John-street, Adelphi, W.C., on Thursday, 25th inst. A council meeting will take place at 7 p.m., and the ordinary general meeting at 8 p.m., when a paper on "A Magnetic Tester for Measuring Hysteresis in Sheet Iron" will be read by Prof. J. A. Ewing, M.A., F.R.S., member.

Royal Institution.—On Tuesday next Prof. George Forbes, F.R.S., will deliver the first of a course of three lectures at the Royal Institution on "Alternating and Interrupted Electric Currents." The Friday evening meetings will be resumed on April 26, when Dr. John Hopkinson will deliver a lecture on "The Effects of Electric Currents in Iron on its Magnetisation."

Society of Arts.—The arrangements for the week ending April 27 are: Monday, April 22, at 8 p.m., Cantor lecture on "Recent American Methods and Appliances Employed in the Metallurgy of Copper, Lead, Gold, and Silver," by Mr. James Douglas (Lecture I.—Mechanical Appliances and Methods in American Metallurgy); and Wednesday, April 24, at 8 p.m., "The Use of Electricity for Cooking and Heating," by Mr. R. E. Crompton, Pres.Inst.E.E.

South-West London Polytechnic. — The new South-West London Polytechnic, Manresa-road, Chelsea, is now rapidly approaching completion, and will, it is expected, be ready for opening at the commencement of the autumn. The governing body have decided to at once advertise for head teachers for the various departments at a commencing salary of £250 per annum. The selection will be made early next month, and the appointments will date from September 1. Forms of application may be obtained from the secretary at the polytechnic.

The Pacific Cable.—The *Times* correspondent at Ottawa says that Australian mail advices from official and private sources respecting the Pacific cable scheme have arrived. In all quarters the importance of the alternative line of communication is fully recognised, and its establishment, as suggested by Canada, is meeting with favourable consideration. Some Governments have already affirmed the principle of State ownership. No valid objection is made by any of the colonies, and the hope is expressed that the home Government will take action soon.

Electricity in Warfare.—The Philadelphia correspondent of the *Times* states that after several years' labour the United States Government has completed on Sandy Hook, for the defence of the entrance to New York Harbour, a sunken mortar battery 500ft. square, enclosed by a counterscarp wall 20ft. high, having a ditch on the inside. Mortar pits are placed at each of the four corners of the earth embankment on the inside, each pit being furnished with four mortars. The pits are connected by subterranean galleries. These 16 mortars, which are worked and fired by electrical devices, each throw a projectile weighing 1,000lb., with a charge of 80lb. of powder, a distance of over six miles.

Exhibition at Croydon.—An electrical exhibition has been held by the Whitgift students in the schools in George-street. It included drawings of electrical apparatus, and apparatus such as for electrolysis of water, simple sounder and single needle telegraphs, fire alarms, telephones, and a burglar alarm working continuous-action bell, fitted up by present students. A lecture on electricity, illustrated by experiments, was given by Mr. J. N. Densham, the head student. Mr. H. T. Haws spoke on the education of an electrical engineer, explaining how to tell whether a boy was fitted to become an engineer, and how to enter the profession, winding up with a few remarks on the subject of lightning conductors.

North-East Coast Institution of Engineers and Shipbuilders.—The eighth general meeting of the session will be held in the lecture hall of the Sunderland Literary Society, Fawcett-street, Sunderland, on Wednesday, April 24, 1895, at 7.40 p.m. The following is the business: (1) Minutes of the last general meeting will be submitted for confirmation; (2) the discussion of Mr. S. O. Kendall's paper on "Turret-deck Cargo Steamers" will be resumed; (3) paper on "The Metric System of Weights and Measures (a plea for its adoption in the United

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Kingdom)," by Mr. G. H. Baines; and (4) discussion. The closing business meeting of the session will be held in Newcastle-upon-Tyne on Tuesday, May 14.

Railway Appliances.—The United Kingdom section of the Imperial Institute is to be augmented during the approaching summer season by an exhibition of railway appliances and inventions. The International Railway Congress, which is to be opened by the Prince of Wales in June, has supplied an opportunity for displaying the capabilities of important branches of British industry connected with the railway services of the country, and the executive council of the institute have undertaken the necessary arrangements. The exhibition will be located in special buildings in the south-east quadrangle of the institute, and several of the leading manufacturers in the United Kingdom will be represented. Many of the exhibits will be shown in motion.

Personal.—Mr. C. M. Van Cüylenburg, of Singapore, who has been home on 15 months' furlough, has whilst here gone through a course in electrical engineering under Mr. Fred. H. Taylor, M.I.E.E., of Ironmonger-lane. He is an officer of the Public Works Department of Singapore. In order to advance with the times, Mr. Cüylenburg has qualified himself in what is acknowledged to be a very necessary adjunct to the duties of an engineer. The governor's house and the residence of the colonial secretary in Singapore are at present lighted by electricity, and not long ago the subject of lighting Singapore electrically was discussed in the local Municipal Council on the initiative of Major McCallum, but owing to the short-sightedness of some of the Commissioners, and a want of spirit in advancing with the times, the project fell through.

A Curious Theory.—A person signing himself "Ratepayers" writes to an Aberdeen paper as follows: "I observe from your columns that the Gas Committee of the Town Council received a deputation representing some consumers of electricity for business purposes complaining of the cost of the electric light, and the committee promised to supply them at about 50 per cent. less than they are doing to ordinary consumers. As a fairly large consumer and as a ratepayer, I object out and out to this unless the charge is reduced to all, which would be consistent and business-like if it is possible to produce it at the price. I hold that every ratepayer is entitled to have it at the lowest rate the Town Council can profitably produce it, and they may depend upon it that those who are consuming it daily will not stand by and permit them to supply it to any section of the trading community at a lower price."

Electric Lighting in India.—In the course of an article on the electric light and transmission of power stations at the works of the Manokji Petit Manufacturing Company, of Bombay, the *Indian Engineer* says: "A noteworthy feature of the electric installations we have been describing consists of the fact that the machinery is wholly supplied by the two firms of which Messrs. Nowroji Wadia and Sons, of Bombay, are the sole agents in India. A firm of agents which practically tests the machinery it imports under the altered conditions, as to climate, etc., in India, deserves well of the public. The secret of success of electric lighting in India in the future lies in a nutshell. Machinery of a superior type and fitting these up under trained supervision are the two essential elements of success in the industry, and an effort by any firm in India in these directions ought to be noticed and encouraged, with as much readiness as the opposite practice should be firmly dealt with and put a stop to by public opinion among the profession."

E.P.S. Accumulators.—The Electrical Power Storage Company have, as noted in our last issue, brought out a new catalogue of accumulators. Among the new developments of the E.P.S. storage cells we note the two types which are specially intended for carriage lighting, mine exploders, etc., where a high discharge rate and good capacity should be combined with low weight. The two types have, we understand, been largely taken up by the Admiralty for electrically firing guns, etc. The capacity of these cells per pound is practically the same as for the ordinary types, while the discharge rate per pound is at quite double that of any other type in the catalogue. When one remembers the great fall in capacity of the commercial storage batteries for abnormal rates of discharge, the great improvement in the two types will be readily seen. The prices of most of the older types have been reduced by 15 per cent., so that a kilowatt for seven hours can now be obtained from accumulators costing £32. 10s. (list price). The catalogue is now conveniently arranged for quickly referring to any particular type.

Electric Lighting at Ballarat.—The *Melbourne Argus* states that Ballarat has been illuminated by electricity. A number of schemes had at various times been considered to that end, and as long as 15 years ago a Melbourne company brought a steam engine there, and depositing it in the vicinity of the Town Hall reserve started on an undertaking involving the lighting of the city. The struggle for existence, however, was brief. The venture was more seriously taken up about a year ago by a number of leading citizens, and the Ballarat Electric Supply Company was formed soon afterwards. Since then 44 arc lamps of 3,000 c.p. have been placed in the principal streets and at the railway station. The work was carried out by Mr. J. A. Dawson, electrical engineer of the School of Mines, under the supervision of the Crompton Electric Lighting Company. The plant includes a right and left Tangye engine, each of 50 h.p., and a boiler of 100 h.p., and is sufficient to supply 500 additional incandescent lamps on the three-wire system, and orders for more than half that number have been received already.

Belfast Exhibition.—The contract for the whole of the electric lighting of this exhibition was placed in the hands of Messrs. Coates and Son in December with instructions to supply 1,000 incandescent lamps of 16 c.p. each and 100 arc lamps of 2,000 c.p. each, thus making the largest contract for electric lighting ever given to an Irish firm. Messrs. Coates's engineer, Mr. Stanley Dashwood, has designed and carried out the installation. Starting from one end of the installation, there is a boiler made by Messrs. Victor Coates. Next to this is a 60-h.p. Victor Coates steam-engine driving by ropes a Holmes "Castle" dynamo. Next to this is a Tangye engine, and then side by side are engines built specially for exhibiting made by Messrs. Crossley Bros.; the Acme, by Messrs. Peter Birt and Co.; the Robey, by Messrs. Robey and Co., Lincoln; the Midland, by Messrs. Taylor and Co.; the Stockport engine, of Messrs. Andrews's make; and a Dick-Kerr engine. These engines are driving eight dynamos made by Messrs. J. H. Holmes and Co., Newcastle-on-Tyne. These were built specially for this work. The arc lamps in the building are of the Crompton-Pochin type.

New York Central and Electric Traction.—The *Financial News* says that, regarding the statement telegraphed from Buffalo that the New York Central management had determined to equip its Niagara Falls branch with electric power, President Depew said: "That matter is now under consideration. We learned that a

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local company had been formed for the purpose of building and operating an electric railway between Buffalo and Niagara Falls, paralleling our own line. It naturally occurred to us that if a new company could build and equip an entirely new road, and run it by electricity at a profit, we ought to be able to profitably apply electric power to a railroad already built and equipped. The proper officers are investigating this subject, with a view to ascertaining its cost and the best methods to be adopted. Undoubtedly the Niagara Power Company, which is now in operation, could be of great assistance to us in making a change from steam to electric power. No definite conclusions have been reached, however." The Niagara Power Company, which has succeeded in utilising the tremendous power of the Falls of Niagara, is a strong corporation financially. Several of its stockholders are identified with New York Central interests. William K. and Frederick W. Vanderbilt hold large blocks of the stock. Mr. Twombly has a considerable amount, and Chauncey M. Depew, J. Pierpont Morgan, and D. O. Mills are also stockholders.

Electrolysed Sea-Water for Sewers.—The executive engineer of the Bombay Municipality has written a letter to the Municipal Commissioner for submission to the Municipal Corporation on the question of the use of electrolysed sea-water for sewers. After describing the system, he says: "In my humble opinion it would not be possible to introduce this system of disinfection on a large scale into the city except at a heavy initial outlay. It would be necessary to provide pumping and electric plant, and to lay a system of water-mains throughout the city, with a large recurring annual expenditure to work the pumping and electric plant and to maintain the water-mains. The executive engineer thinks that if a reliable experiment is to be made, the best place would be the Carnac Bundar nightsoil depôt. The total approximate cost of the whole installation would be Rs.60,000. It is, he says, for the Corporation to decide whether an experiment, which is to cost Rs.60,000 at first and a recurring monthly expenditure of Rs.1,312-8-0, should be made. I may state, however, that I doubt whether the value of an experiment such as this is worth the expenditure proposed to be incurred." In conclusion, he states that although as the Hermite system of electrical treatment is at present in its infancy, and much cannot be gained by an experiment in Bombay, there is no doubt that as the science advances, and more progress is made by experts in England and on the Continent, the invention will prove important and effective in carrying out the object sought to be obtained.

Crystal Palace School of Practical Engineering.—The certificates which have been gained by the students of the above school during the past term have been presented to the successful candidates by Mr. J. C. Hawkshaw, member of the council of the Institution of Civil Engineers, in the lecture theatre of the school. The report of the examiners stated they had much pleasure in bearing testimony to the degree of excellence which had been attained. They could not speak too highly of the work carried out in the pattern shop, while the work in the fitting shop was also worthy of high praise. Mr. Hawkshaw, before presenting the certificates, delivered a short address to the students, in which he reminded them of the advantages they enjoyed in being able to attend the course of instruction at the Crystal Palace School. It was an advantage which many older engineers who had had a hand in building up the profession had never experienced. He pointed out that it was not by books and teaching alone they could become engineers, but an acquaintance with outdoor work was absolutely indispensable, and they must not think, when they were on works in progress, that they could neglect this outdoor work. They should go daily round the work, see with their own eyes and note everything that was going on, for the better observers they were the better engineers they would make. He exhorted them not to think that the business of the engineer lay solely in designing, and that it was the business of the contractor to carry the design out without supervision. Mr. Hawkshaw then presented the certificates. The first in order of the students of the first year's course were:—Mechanical engineering: Mr. E. Byron and Mr. T. C. Hassirdjoglow (bracketed); drawing office: Mr. F. G. Brooker; pattern shop: Mr. W. T. Harbord; fitting shop: Mr. D. H. Slack. The certificates for the second year's course were gained as follows:—Civil engineering: first term, Mr. F. G. Motley; second term, Mr. C. W. Wales; third term, Mr. D. K. McMinn and Mr. F. B. Nicholson (bracketed); fourth term, Mr. G. Stirling. Electrical section: first term, Mr. L. de Ridder; second term, Mr. F. E. Skipwith. Colonial section: Mr. A. W. Redfern and Mr. W. Riddell.

Royal Meteorological Society.—At the meeting of this society on Wednesday evening, the 17th inst., which was held at the Surveyors' Institution, Westminster, Messrs. F. C. Bayard and W. Marriott communicated a paper on "The Frost of January and February, 1895, over the British Isles." The cold period, which commenced on December 30, and terminated on March 5, was broken by a week's mild weather from January 14 to 21, otherwise there would have been continuous frost for 66 days. Temperatures below 10deg. F., and in some cases below zero, were recorded in parts of England and Scotland between January 8 and 13, while from the 26th to the 31st, and from February 5 to 20, temperatures below 10deg. occurred on every day in some part of the British Isles. The coldest days were February 8 to 10. The lowest temperatures recorded were 17deg. at Braemar and 11deg. at Buxton and Drumlanrig. The mean temperature of the British Isles for January was about 7deg., and for February from 11deg. to 14deg. below the average, while the mean temperature for the period from January 26 to February 19 was from 14deg. to 20deg. below the average. The distribution of atmospheric pressure was almost entirely the reverse of the normal, the barometer being highest in the north and lowest in the south, the result being a continuance of strong northerly and easterly winds. The effect of the cold on the public health was very great, especially on young children and old people. The number of deaths in London due to diseases of the respiratory organs rapidly increased from February 2 to March 2, when the weekly number was 1,448, or 945 above the average. Rivers and lakes were frozen, the ice being more than 10in. thick. The frost will long be remembered for its effect on the water-pipes all over the country, in many cases householders being without water for more than nine weeks. As the result of enquiries, the authors find that mains have frozen which have been laid as low as 3ft. 6in. from the surface of the ground to the top of the pipe. It appears, however, that the nature of the soil had far more to do with the depth to which the frost penetrated than the intensity of the frost itself. From a comparison of previous records, the authors are of opinion that the recent frost was more severe than any since 1814. Mr. Birt Acres also read a paper on "Some Hints on Photographing Clouds."

An Important Enterprise in Mexico. — An interesting electric power installation is now under construction for the Cia. Anonima de Transmission Electrica de Potencia, located in the State of Hidalgo, some 100 miles north of the city of Mexico. The water is taken from

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the Arroyo de Regla, a mountain stream having a minimum supply of 1,500 cubic feet per minute. A natural rock dam at a point in the canyon impounds the water sufficiently to admit of its being diverted by a cut through the bluff into a canal, which follows mostly the contour of the mountain, a distance of 1½ miles. This involved the cutting of seven tunnels, aggregating a total length of 1,200ft. through solid rock. From the terminus of the canal the water is carried to the power station through 1,700ft. of 30in. pipe, which affords a vertical head of 800ft., this being of varying thickness to correspond to the pressure at various points on the line, the lowest portion being made of steel ¾in. thick. The pipe line discharges into a receiver 40in. diameter by 75ft. long, with which the wheels are connected by lateral branches. This is made of flange steel plates ¾in. thick, tested to 700lb. water pressure, and weighs upwards of 50,000lb. The power station consists of five Pelton wheels 40in. diameter, of capacity of 400 h.p. each—direct connected to the same number of 12-pole three-phase generators running at a speed of 600 revolutions, delivering the current at a pressure of 700 volts; also two 24in. Pelton wheels, speeded at 1,700 revolutions, for running the exciters. The step-up transformers are wound for a ratio of 1 to 15, making the line potential a little over 10,000 volts at the generator end. There are three transformer sub-stations in which air-blast transformers are to be used. Pelton differential governors are attached to each wheel for purpose of regulation. This station is to supply power to the mines of the Rio del Monte Company, employing upwards of 8,000 men. The power is to be used for operating mining machinery, such as stamp mills, crushers, pumps, hoists, ventilators, etc. The mines of this company—said to be the richest in Mexico—are located within a radius of 20 miles, the maximum distance of power transmission being 23 miles, and the mean distance about 18 miles. Various other mines in the vicinity will also be supplied with power from this station, and the city of Pachuca also furnished with light.

The Nature of Electricity.—At the last meeting of the Boston (U.S.A.) Scientific Society, Prof. A. E. Dolbear presented a paper entitled "The Nature of Electricity." Prof. Dolbear first gave consideration to fundamental notions in physics, speaking of the phenomena and factors thereof, these being matter, ether energy, and motion; the properties of ether being that it is continuous, non-molecular, frictionless, elastic, and energised. The origin of electricity was next discussed, this being either from friction, chemism, or heat for its direct production or induction for its indirect production. Consideration was next given to the ether, which, with its properties, becomes the medium in which exist gravity, light, magnetism, and electricity. The definitions which have been given for electricity were then reviewed, it having been considered a form of energy, a form of motion, energy itself, a form of motion of matter, a form of motion of ether, etc. Edlund defined it as ether itself; Lodge thinks it to be a wave motion in ether; Roland considers it a property of matter; while Trowbridge assigns its place among the great unknowables. As to its origin, electricity must have some antecedent motion. When the face of the thermopile is heated, we know that vibratory motion is the condition for its appearance; while in the battery, chemical action is the source, and the heat equivalent of this is a measure of the electricity produced. In glass, wax, etc., mechanical friction produces it, and when a conductor is moved in a magnetic field and electricity results, this will stop on the cessation of the motion. In every case the mechanical motion turned into it is the antecedent, and the energy of the engine is represented by the electricity developed. From motion, then, results energy; and if it be molecular motion we call it heat; if ether waves, we call it light; if molecular exchange, we call it chemism. And all electrical action is motion between matter and ether. As a summary of his arguments, Prof. Dolbear brought forward the following propositions: Energy is an embodiment of motion in some medium and does not exist independently, while the so-called forms of energy are due to the different kinds of motion a body may have. Transformation of energy is a change from one kind of motion to some other kind. Electricity never appears except when some known form of motion of matter is antecedent, and continuity of motion is a logical and experimental necessity; hence electricity must be a condition of thing in matter or else a condition of things in ether.

Code Telegrams.—"W. B." writes to the *Times* as follows: "In the preface of the official vocabulary of words selected for use in code telegrams throughout Europe, compiled and issued by order of the International Telegraph Conference, Paris, 1890, the following sentence occurs: 'Pour la dissemblance typographique et télégraphique des mots entre eux, il a été adopté comme règle que *chaque mot doive différer de tout autre mot d'au moins deux lettres* et de trois signes élémentaires Morse.' It is further stated (presumably to prove how carefully the work of compilation has been performed) that three systems of checking the words were resorted to, in order to ensure the above results. I have just devoted a couple of hours to a cursory examination of the English words only in the official vocabulary. The following words are to be found therein:

Awful	and	Lawful	Drainage	and	Trainage
Awfully	,,	Lawfully	Fitness	,,	Witness
Awfulness	,,	Lawfulness	Gardening	,,	Hardening
Boasts	,,	Coasts	Gazier	,,	Glazier
Brawlingly	,,	Crawlingly	Hawkish	,,	Mawkish
Budging	,,	Fudging	Knightly	,,	Nightly
Burnish	,,	Furnish	Liability	,,	Pliability
Burnishing	,,	Furnishing	Lumpishly	,,	Mumpishly
Comelily	,,	Homelily	Singingly	,,	Stingingly
Dobber	,,	Jobber	Steamer	,,	Streamer

I have also come across many words whose telegraphic signals are most unsuitable for code telegraphy. I happen to have a practical knowledge of telegraphy, and I have devoted upwards of a couple of years to selecting a vocabulary of words for a private telegraphic code. The experience I acquired leads me to think that, if I checked the official vocabulary systematically, I should find it contains many hundreds of words which, from one cause or another, are unsuitable for telegraphic purposes. That such a vocabulary should be issued under the sanction of the representatives of the European States of the International Telegraph Conference reflects but little credit on the arbiters of the telegraphic communities of Europe. But that such an ill-selected vocabulary should be compulsorily forced upon the mercantile communities of Europe three years hence should be most strongly protested against without delay. The extreme importance of using a well-selected list of words for code telegrams is well known to everyone who has a practical knowledge of telegraphy. I believe that the next meeting of the International Telegraph Conference will be held in the course of the next few months. It is full time that the British Chambers of Commerce, whose interests are threatened and imperilled by the arbitrary law regarding the compulsory adoption of the official vocabulary in January, 1898, should take energetic measures to protect British trade. They should insist on a revised edition of the official vocabulary being issued, or the law regarding

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its compulsory adoption being rescinded. In the event of a revised edition being issued, it would rest with the International Telegraph Conference of 1895 to atone for its shortcomings by making adequate provision for entrusting the work of revision to men who are qualified to compile a standard official vocabulary more worthy of the name than the one under remark."

The Falls of Foyers.—Mr. S. R. Crockett is a novelist. Novels require advertising. It is not a bad way to advertise a novel for the novelist to advertise himself by rushing into print in the dailies when an opportunity presents itself. Mr. Crockett, who is a Scot, has at once jumped at the chance presented by the *Daily Chronicle* in the article to which we referred last week. He writes: "I have read the article in the *Chronicle* on the proposed 'capture' of the Falls of Foyers with something like stupefaction. It has long been a subject of profane levity with the travelled foreigner that in this country we have many fine falls, only at most of them we have forgot to turn on the water! Hitherto, we have always been able to refer such cavillers to the Falls of Foyers, situated in the united parishes of Boleskine and Abertarf, and this combination of orthography and topography has invariably served to upset the scorner's chair. But now Foyers is to be 'piped' like Baku paraffin, and syphoned away—spray, rainbow, and all—to do work to the amount of so many foot-pounds per hour. And the end of it all is—aluminium. Well, we can always go and gaze at the rocks, at any rate. But, alas! no shilling will serve to send the boy up to turn on the water, as at a certain Welsh fairy glen renowned in story. It was a dry year when the visitor made his appearance. The proprietor was willing that he should gaze on the works of Nature. He stood before the falls. 'Now,' said the guide, 'it is a shilling if you please, and I will send up the boy to turn on the water!' If, however, the Inverness County Council listens to the tempter, here is an inscription ready made with which to span the arid rocks:

God made the Falls of Foyers.
The British Aluminium Company makes aluminium.

And above might be placed a painted metal rainbow. Indeed, the whole sad tale reads like Milton's account of the first temptation of Eve. It would, of course, be entirely misleading to suppose that there is any resemblance between the manufacturers of aluminium and the tempter—

Squat like a toad, close at the ear of Eve
Essaying by his devilish art to reach
The organs of her fancy, and with them forge
Illusions as he list, phantasms and dreams.

But there certainly is some analogy between the sleeping Eve—yet beautiful, guileless, innocent—and the Inverness County Council. The 'advantages' to the town are undoubtedly good to eat and pleasant to the eyes. But this thing once done can just as little be undone as the former. And it may be—though of this we are not positive—that the 'illusions, phantasms, and dreams,' all trifles light as air, may have some connection with aluminium, which I am informed is one of the lightest of metals, and, like man, made from clay. At all events, you, Sir, have undeniably a good claim to be that Ithuriel of the Spear who touched lightly the hidden shape and revealed its monstrous reality. Surely, even the memory of Robert Burns, who wrote a poem standing beside the falls in commemoration of their beauty, and of Christopher North, who justly declares them to be the most magnificent cataract, out of all sight and hearing, in Britain, might be enough to keep the Vandal at bay, and to let the sunshine continue to illumine the spray, in token that the Falls of Foyers shall not be destroyed while the world lasts.' Whether this is meant seriously or comically we do not pretend to know. If the latter, Mr. Crockett resembles the Scot of a certain story who "joked with deeficulty."

Electric Lighting in Glasgow.—A correspondent writes to a Glasgow paper as follows: "Apropos of the opening of the electric lighting station at Edinburgh on the 11th inst., this question presents itself to me—viz., what is the Glasgow Corporation doing towards the developing of the electric light department under it? A few of the principal streets have been lighted by arc lamps, and are no doubt an improvement and an advance in the right direction. The low-tension network for private distribution has also been spread over the north-western part of the city to a considerable extent, and when fully taken advantage of will, I have no doubt, tax to the load-limit the capacity of the generating plant at Waterloo-street. But looking at this subject from a ratepayer's point of view, what answer have we to the question, Does it benefit the city, and is it paying? In face of the great bridge scheme and the historic weir, one looks upon all such new ventures with a critical eye, and I am afraid, if truth were told, this department would be a white elephant, or if not white, certainly verging towards the colour of that profit-consuming creature. And that for a few reasons, principally lying in the fact that nothing is being done by the Commissioners to popularise its being used, and to keep the fact before the citizens that the electric light mains are in their vicinity; and, further, that during the summer months, when so little light is required, no means are used to encourage the use of the current for other purposes than lighting, thus causing three-fourths of the plant to stand useless. Now, at first sight these points may seem of little moment, and the latter may be satisfactorily answered to some enquirers by saying, what other result could you hope for? But let us look at the steps taken by other municipalities, and we find a characteristic difference. We find that every means is taken to popularise and keep before the public in whose vicinity the electric mains are the advantages to be gained by its adoption, and, further, that a special rate being fixed per unit for lighting, usually from 5d. to 8d. (in Glasgow 6d. per unit), when a current is used for motors, heating, or any other purpose other than illuminating, a large reduction is made per unit, generally from 3½d. to 4½d. being charged, current being registered through a different meter. One other advantage arising from the use of current for motors, elevators, heating, or ventilating, is that it is generally more in demand during daytime, when light is not so much in demand, and a supply can readily be given for this work without interfering in any way with the lighting capacity of the plant in the evening. In George-street the gas department have a selection of gas cooking stoves, gas heating stoves, and various appliances designed for the use of gas, the hiring of which during the summer season must raise what would otherwise be a comparatively low gas consumption at that particular season. Similarly in another direction the market is stocked with appliances for the use of electric current, and are both more useful and cleaner in application than gas can ever be. But we look in vain for such productions from the Corporation warehouse. Therefore, I think one is justified in asserting that more can be done for this department to keep it in advance with the times, and that, instead of waiting until it is a failure, steps ought to be taken to give it an impetus in the direction of popularity and economic production, as it is evident the more steady the consumption of current the greater will be the saving. It is therefore to the immediate interests of the citizens that this be looked into."

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THE PHOTOGRAPHIC TESTING OF PROJECTOR REFLECTORS.*

BY V. TCHIKOLEFF.

The military search-lights now used for lighting at great distances have reflectors of silvered glass, which have in principle considerable advantages over the metal reflectors and refractors formerly used. The fault of the Mangin reflecting refractors of glass used in France and other

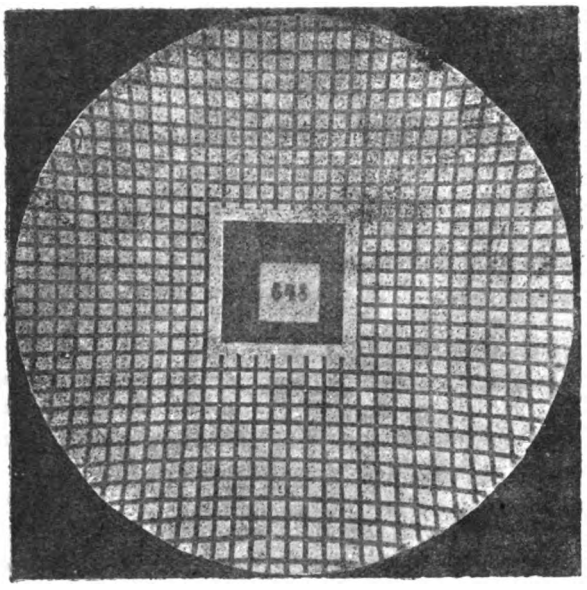

FIG. 1.

countries consists in the impossibility of constructing a parallel optical system when the focal length is less than two-thirds of the diameter of the reflectors. The spherical reflectors of silvered glass used in England, and even the arrangement designed by the author for use in Russia, have a considerable amount of aberration, and cannot be worked with a focal length less than five-ninths of the diameter of the reflectors. The glass parabolic reflectors made by Schuckert have a focal length equal to about one-third of the diameter.

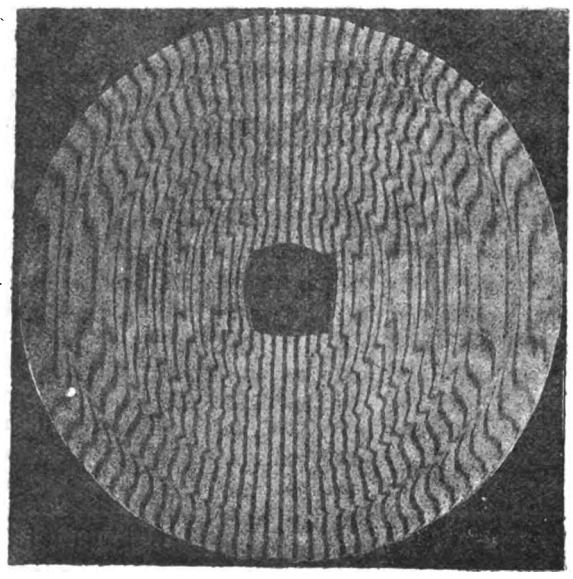

FIG. 2.

The Tchikoleff system of meniscus rings perfected by Siemens is the only one able to compete with the Schuckert reflectors, but the manufacture of apparatus on this system has been hindered by the defective construction of similar apparatus by Ratenau, which have not all the necessary accessories. In fact, the Schuckert reflector still remains the one for powerful lights, and can hold its ground provided the surfaces are made with sufficient regularity. The regularity of the spherical surfaces of the Mangin projector is assured by the method used in polishing it, while the regularity of the parabolic surfaces depends on the exactness of the lathe and on the workman.

The author from his experience considers that the Schuckert reflectors are not regular in outline, and that all differ more or less from the parabolic curves. As all the advantages of this reflector may vanish if the two surfaces (back and front) are not sufficiently regular, the author now considers the practical and certain means of controlling the regularity of these surfaces. His first idea was to use a spherometer of large size, but

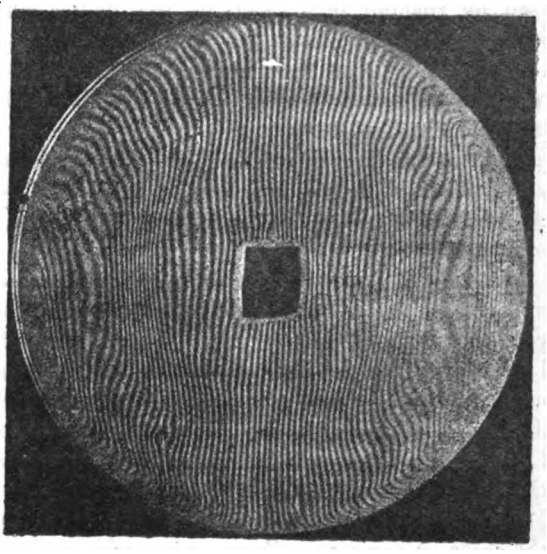

FIG. 3.

he had to give it up on account of the high price of an apparatus of this kind, and the accuracy of its construction could not be relied on. Even then the anterior surface of the mirror could be controlled by the spherometer. As to the posterior surface, the testing, etc., could not be conducted before silvering with the same instrument as before. The author had then recourse to an optical method. He placed a luminous point in the focus and studied the image reflected from different parts of the reflectors. This method necessitated the construction of

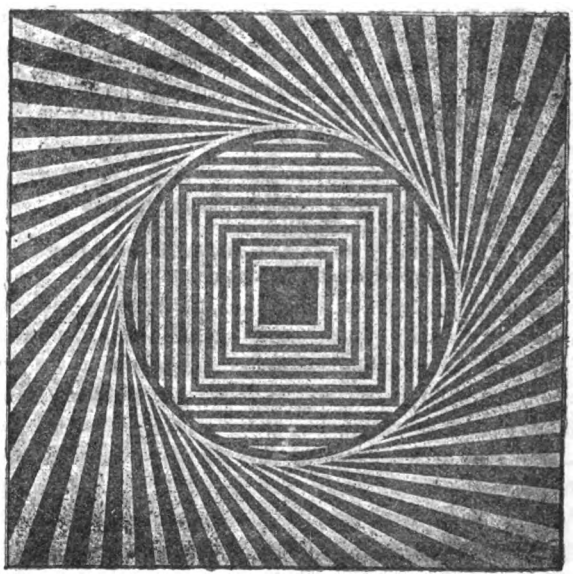

FIG. 4.

an envelope of wood for the projector, which must be capable of rotation round the same horizontal axis as the reflector, but independently of it. The difficulty of getting the two rotating bodies to revolve round the same optical axis has proved to be practically insurmountable, and at the same time to be very costly. In short, both methods have the following faults—that the difficulty of control is great, and that the results are based on subjective impressions, which give no record.

The author has devised another method, which consists

* *L'Eclairage Electrique.*

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of photographing the image in the projector of a white screen covered with a black squared network. The results obtained thus are easily photographed when the screen is illuminated with an arc lamp. The first steps in the process are as follows: the reflector is removed from the lantern and placed at a distance of from 3ft. to 5ft. from the screen. This screen is of white material having a black squared network, the lines being ·2in. thick and ·6in. apart. In practice, at the centre of the screen a square opening is left (·8in. square) through which the photograph of the image of the network can be taken. The screen

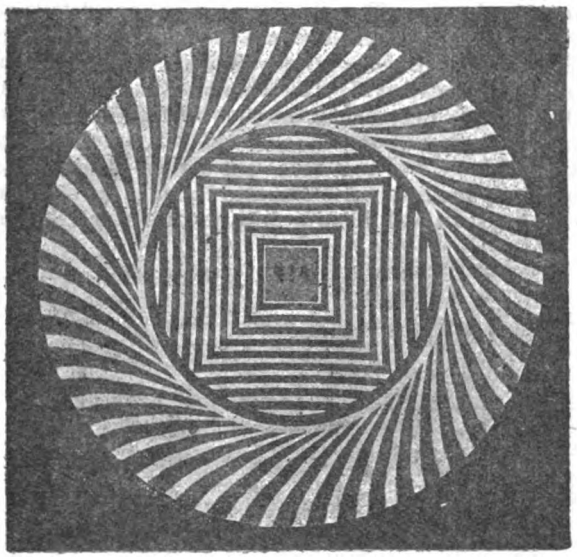

FIG. 5.

should exceed by 30 to 35 per cent. at least, the height and breadth of the projector. When the apparatus is arranged, it must be large enough to ensure that the image of the network covers the whole surface of the mirror.

The testing of the reflector is conducted as follows:

(1) The surface of the mirror in all planes is tried by a template to assure that, in general, the exterior curves of the surface are not far distant from the parabola. The uniformity of the thickness of the bed of glass, judged by

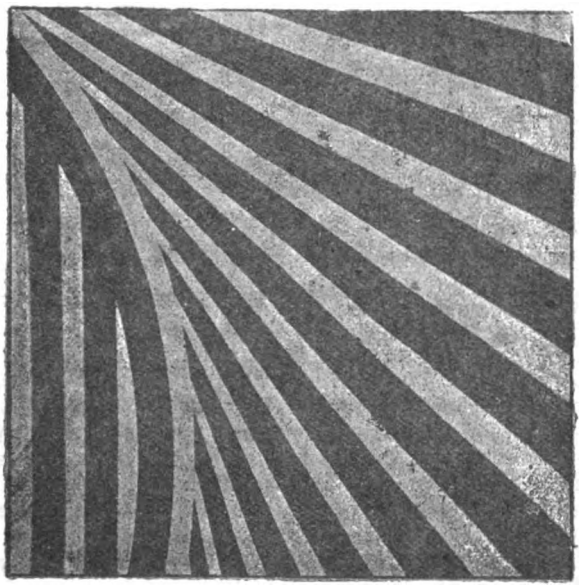

FIG. 6.

eye, allows of an approximate idea as to whether the two surfaces—interior and exterior—are parallel.

(2) The image of the screen on which the parallel lines are traced is photographed, which allows of the small defects on the surface of the reflector being observed.

(3) The image of the screen carrying the network is photographed. This better indicates the irregularities of the centre of the reflector, whereas the former test gives a better idea of the extremities.

(4) A photograph is taken of the projections of the electric light reflected by a reflector on the screen. Serious errors on the parabolic surface cause circles and dark spots. Small imperfections invisible to the naked eye can also be brought out by photometric processes, which augment the differences between light and dark.

In Fig. 1 we show a photo taken of a Mangin reflector 35½in. in diameter at a focal distance of 23·7in. Fig. 2 represents a parabolic reflector of glass very badly ground. Fig. 3 shows a metallic parabolic reflector hammered to shape, and then polished without grinding. An experi-

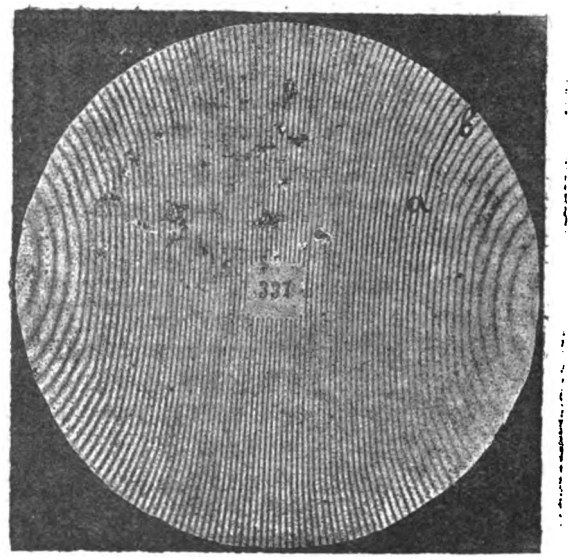

FIG. 7.

ment has also been made in photographing a screen image with tangential lines, as shown in Fig. 4. A similar figure presents this advantage, that all the lines are symmetrically and equally distorted. In Fig. 5 there is seen the image of the screen in a glass parabolic mirror. It will be noticed in Fig. 6 that the black rays are composed of three shades. This is the photograph of a portion of a mirror. The lightest part is due to the reflector on the front surface of the glass; the next to the reflector on the silver bed; and the darkest to the coincidence of the two. Figs. 7 and 8

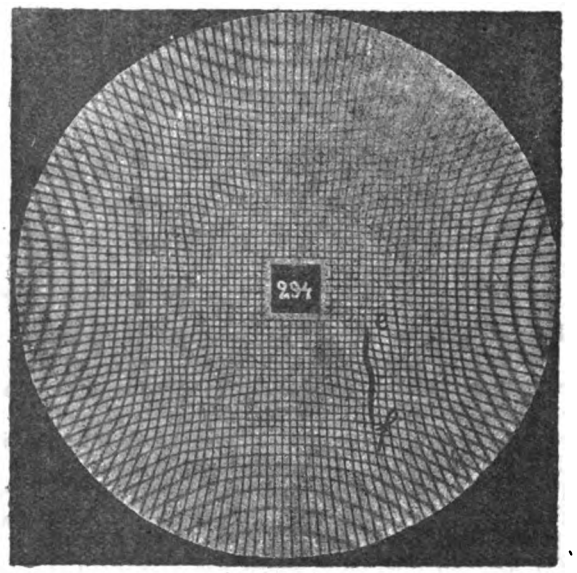

FIG. 8.

show the faults in a Schuckert mirror due to errors in grinding, etc.

ELECTRIC LIGHTING OF TRAINS.

BY R. W. WEEKES, WHIT.SCH., A.M.I.C.E

The question of the best system of electrically lighting trains is yet an open one, and the engineers in England have so far given more attention towards the practical

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decision of this matter than any railway engineers abroad. The requirements of a perfect train-lighting system are as follows:

(*a*) The arrangement and subdivision of the light in the compartments should be convenient, and the candle-power sufficient to enable current literature to be read anywhere in the compartment.

(*b*) The voltage of supply must be steady, whether the train is running or not.

(*c*) Each individual carriage should contain its own source of electrical energy, to enable the train to be uncoupled anywhere or a carriage to be slipped.

(*d*) If the driving power for the dynamo is obtained from the axle of the carriage, the subsidiary apparatus to ensure constant potential at all speeds should be as simple as possible, and easy of adjustment and repair.

(*e*) All mechanical parts should be strong, and capable of standing vibration.

(*f*) The first cost should be reasonable.

(*g*) The working cost should compete with rival illuminants.

axles of the carriage has been largely used in this country. In America, Lieutenant I. N. Lewis has taken the matter up, and devised an apparatus which is described below. The great difficulty in all such arrangements is to ensure good regulation in spite of the great variations in speed of the trains. To this end, a number of automatic devices have to be used, and it will be interesting to compare our English practice with that of Lieutenant Lewis's. His apparatus consists of a dynamo fixed on the car truck itself, and flexibly belted to the car axle, which charges a storage battery of 12 cells carried under the car and at the same time, if necessary, supplies current for lamps in the car. The illustration shows the details of the connection between the dynamo and the car axle, and also the arrangement of the various circuits. The Lewis dynamo employed is one having a maximum output of 25 volts and 50 amperes. Rectangular carbon brushes are used, which are fixed in position. The machine is iron clad, being fitted with a close iron cover protecting the commutator, fields, and the brushes. Graphite bearings are used for the armature shaft and do away with the use of oil. The frame

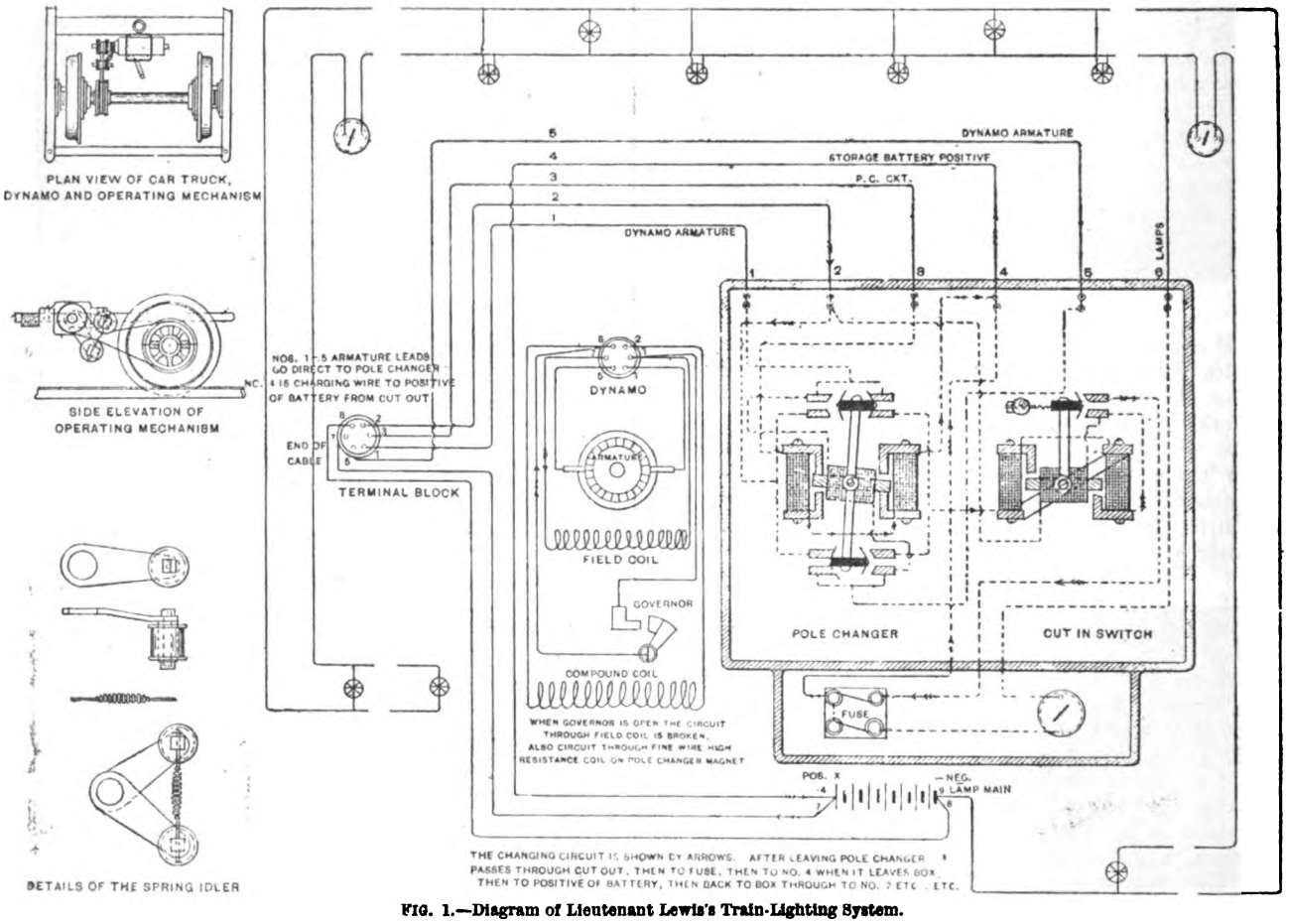
PLAN VIEW OF CAR TRUCK, DYNAMO AND OPERATING MECHANISM
SIDE ELEVATION OF OPERATING MECHANISM
DETAILS OF THE SPRING IDLER
DYNAMO ARMATURE
STORAGE BATTERY POSITIVE
P.C. CKT.
DYNAMO ARMATURE
9 LAMPS
NOS. 1-5 ARMATURE LEADS GO DIRECT TO POLE CHANGER
NO. 4 IS CHARGING WIRE TO POSITIVE OF BATTERY FROM CUT OUT
END OF CABLE
TERMINAL BLOCK
DYNAMO
ARMATURE
FIELD COIL
GOVERNOR
COMPOUND COIL
WHEN GOVERNOR IS OPEN THE CIRCUIT THROUGH FIELD COIL IS BROKEN. ALSO CIRCUIT THROUGH FINE WIRE HIGH RESISTANCE COIL ON POLE CHANGER MAGNET
POLE CHANGER
CUT IN SWITCH
FUSE
POS. X
—NEG.
9 LAMP MAIN
THE CHANGING CIRCUIT IS SHOWN BY ARROWS. AFTER LEAVING POLE CHANGER IT PASSES THROUGH CUT OUT, THEN TO FUSE, THEN TO NO. 4 WHEN IT LEAVES BOX, THEN TO POSITIVE OF BATTERY, THEN BACK TO BOX THROUGH TO NO. 2 ETC., ETC.

FIG. 1.—Diagram of Lieutenant Lewis's Train-Lighting System.

It is needless to state that no present system is completely in accordance with the above, and I am sure that the engineers who have worked so long in the direction which they consider leads to that end will admit that their labours are not ended. The systems of electrically lighting of trains can be classified as follows:

(1) Lighting from accumulators placed in each carriage which are charged from a dynamo in the guard's van, which is driven from the axle of the carriage.

(2) Accumulators only, which are recharged at the end of the journey *in situ*, or removed and replaced by other charged cells.

(3) Direct lighting from a coupled plant, consisting of dynamo and high-speed engine supplied with steam from the locomotive boiler.

I propose to describe with sketches and diagrams examples of these various systems and their many variations, and, finally, to draw conclusions as to the direction in which the figures obtained from actually working them tend.

(1) The systems in which the dynamo is driven from the

is bolted to the bolster or truck beam, and connected by a raw-hide belt, 3in. wide, to a 20in. pulley on the axle, the armature shaft carrying a 7¾in. pulley. The distance between pulley centres being small, the belt is kept tight on the armature pulley by a pair of spring idlers, consisting of two flanged pulleys, 4½in. in diameter, over which the belt runs, revolving in graphite bearings and held together by the spiral spring on each side with adjustable nuts.

The distinguishing feature of this system is the way the dynamo is wound, through which it is made self-regulating for all speeds, and gives a nearly constant potential at the battery terminals without employing any of the auxiliary regulating devices heretofore necessary in axle-driven dynamos to obtain this constant E.M.F. at varying speeds of the train. This regulation Lieutenant Lewis accomplishes by a reverse winding of the series coil, the current passing through this coil going in an opposite direction to that in the shunt; the latter is fed from the storage battery, and its circuit automatically opened by a switch on the end of the armature shaft in order to prevent waste of the battery current when the car is standing still. By this

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means the E.M.F. does not vary more than a few volts, notwithstanding large variations in the speed of the train.

Next to the dynamo the important features of the system are the pole changer and the automatic cut-out. The former ensures that the charging current is always of the same polarity, and the latter cuts out or cuts in the storage battery when the dynamo voltage falls below or when it attains a specified amount, thus preventing the battery from discharging through the dynamo in the former case. Both of these are placed in a small box with a glass face, which may be put up anywhere in the car, as no attention is required.

The pole changer consists of an electromagnet in the form of a vertically pivoted lever, with contact brushes on one end, and through whose coils the armature current passes. The lever is so arranged as to be controlled by two other electromagnets receiving their current from the storage battery. Should the direction of the car be reversed, the reversal of the armature current would follow, the polarity of the lever would be changed, and it would be repelled from the magnet which formerly attracted it and attracted by the one which before repelled it; in the new position the lever would thus be forced to take, it would, by means of the brushes on its end, reverse the relation between the armature and storage battery poles, thus sending the current through the battery in the same direction as before.

The cut-out switch consists of a pivoted electromagnet connected to the storage battery circuit, facing another electromagnet through which the armature current flows. When the current in the latter attains a certain strength, the lever magnet is attracted against the face of a spring, thus making the charging current, which is broken when the current falls below the specified amount or is reversed.

The accompanying diagram, which shows the wiring of the car on Mr. Lewis's system, illustrates the several features above described. The battery in this case will furnish about eight hours' lighting when the car is stationary. This description is taken from a paper read by Mr. M. B. Leonard before the Association of Railway Superintendents in America, and other reference to this valuable paper will be made in the following articles.

The storage batteries which according to Mr. Leonard have been the most satisfactory are the chloride accumulators. The batteries are carried in a box under the car out of the way, which is pierced with holes to allow the gas evolved in charging to escape. With four or more cars they are fitted with a special form of switch which opens the charging circuit automatically whenever the battery is fully charged, thus preventing unnecessary drafts on the locomotive for power. As the apparatus does not operate until the train has attained a speed of about 20 miles an hour, no extra work is imposed on the locomotive in starting the train. The entire apparatus is entirely automatic in its operation, requiring no expert attention, except a periodical inspection at the terminal points, and has given excellent satisfaction on the Chesapeake and Ohio Railway, as well as on the car that has been running for some time on the Brooklyn Bridge in New York, where another one is about to be installed.

Analysis of the Lewis System.

It will be gathered from the above description that the regulation of the voltage is effected by demagnetising series coils. Mr. Leonard, as superintendent on the lines on which this system is being tried, considers this method satisfactory, and says that there is only a variation of a few volts. It is difficult to see how, in the first place, the dynamo can give constant volts. Assume that at 20 miles per hour the voltage current and field strength are normal, then at 60 miles per hour the field of the dynamo must be reduced to one-third of its normal value. It is obvious to any careful investigator of problems in dynamo design that this change can only be effected when the rising part of the characteristic curve is used. Even then a considerable change of current will be required to vary the field to this extent.

On looking through the diagram of connections, Fig. 1, it will be seen that the dynamo is working on to the accumulators and lamps in parallel. Hence a change in current cannot take place unless there is a change in voltage. This points to the fact that the apparatus cannot possibly give constant voltage, but that the pressure must rise with the speed. This is not a radical defect unless the variation is excessive. A similar argument can be applied to nearly all engine governors. In fact, a commercial governor which regulates the speed without more than 5 per cent. variation between no load and full load is an exceptionally good one.

Now, for lighting purposes a similar variation of 5 per cent. in the voltoge may give 50 per cent. variation in the light, and this would be objectionable. Of course, the designer of this system may have reduced the variations below 5 per cent. Without wishing to unduly criticise the design, I would also point out that working on the rising, and therefore unstable part of the characteristic curve, is always unsatisfactory where exact voltages are required. Again, we do not see in the diagram any device for reducing the pressure on the lamps when the accumulators are being charged in parallel with them. In fact, the connection would, if used with lead accumulators as in the block, give a variation of some 20 per cent. in the voltage. At speeds below, say, 15 miles per hour, the lamps are supplied at the discharging voltage of the accumulators, and at high speed they are subjected to the full charging voltage. The chloride accumulator may not give this variation, but I have no record of their charging and discharging voltages. This defect can be remedied by using automatic arrangements, as devised by Mr. W. Langdon for the Midland Railway Company.

The machinery had not been working more than six months when Mr. Leonard obtained the following figures, and hence they are likely to be too favourable to the system, as the repair bill will not have reached its normal value. He states that the cost of fitting up per carriage, having in it 12 lamps of 16 c.p., was £102. 10s., and that the cost of lighting it for 10 hours per day was 1s. 11¾d.

I propose at the end of my series of articles to compare in list form the costs of all the systems, and hence reserve comment on the figures till then.

(To be continued.)

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 397.)

49. *Dimensioning of Magnet Cores.*—The sectional area of the magnet cores being found by means of the formulæ and tables given in Chapter 48, their length and their relative position must be determined.

(*a*) *Length of Magnet Cores.*—In the majority of types the length of the magnet cores has a more or less fixed relation to the dimensions of the armature, and definite rules can only be laid down for such cases where the length of the magnets is not already limited by the selection of the type.

Two points have to be considered in dimensioning the length of the magnets. The longer the cores are made the less height will be taken up by the magnet winding; the mean length of a convolution of the magnet wire, and consequently the total length of wire required for a certain magnetomotive force, will, therefore, be smaller the greater the length of the core. On the other hand, the shorter the cores are chosen the shorter will be the magnetic circuit of the machine, and, in consequence, the less magnetomotive force will be required to set up the necessary magnetic flux.

Of these two considerations—economy of copper at the expense of additional iron, on the one hand, and saving in magnetomotive force and in weight of iron, on the other—the latter predominates over the former, from which fact follows the general rule to make the cores as short as is possible without increasing the height of the winding space to an undue amount.

In order to enable the proper carrying out of this rule, the author has compiled the following Table LXIII., which gives practical values of the height of the winding space for magnets of various types, shapes, and sizes.

* From the *Electrical World* (New York).

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TABLE LXIII.—Height of Winding Space for Dynamo Magnets.

Size of core.		Bipolar types.				Multipolar types.			
		Cylindrical cores.		Rectangular or oval cores.		Cylindrical cores.		Rectangular or oval cores.	
Diameter of circular cross-section.	Area of rectangular or oval section.	Height of winding space.	Ratio of winding height to diameter of core.	Height of winding space.	Ratio of winding height to diameter of equal circular section.	Height of winding space.	Ratio of winding height to diameter of core.	Height of winding space.	Ratio of winding height to diameter of equal circular section.
In.	Sq. in.	In.		In.		In.		In.	
1	·8	½	·50	—	—	¾	·75	—	—
2	3·1	¾	·375	1	·50	1¼	·625	1½	·75
3	7·1	1	·33	1¼	·42	1½	·50	1⅞	·625
4	12·6	1¼	·31	1⅝	·41	1⅞	·47	2¼	·56
6	28·3	1½	·25	2	·33	2¼	·375	2⅝	·44
8	50·3	1¾	·22	2½	·31	2⅞	·36	3	·375
10	78·5	2	·20	2¾	·275	3¼	·325	3½	·35
12	113·1	2¼	·18	3	·25	3⅝	·30	4	·33
15	176·7	2¼	·15	3¼	·22	4	·27	4½	·30
18	254·5	2⅝	·13	3½	·20	4⅜	·24	5	·28
21	346	2⅞	·12	3¾	·18	4⅞	·23	5½	·26
24	452	2⅝	·11	4	·17	5¼	·22	6	·25
27	573	2¾	·10	4¼	·16	5¾	·215	6¾	·25
30	707	3	·10	4½	·15	6¼	·21	7½	·25
33	855	3¼	·099	5	·15	6¾	·205	8¼	·25
36	1018	3½	·097	5½	·15	7½	·2	9	·25

In bipolar machines, such as the various horseshoe types, in which the length of the magnet cores is not limited by the form of the field-magnet frame, the radial height of the magnet winding in case of cylindrical magnets varies from one-half to one-tenth the core diameter, according to the size of the magnets, and in case of rectangular or oval magnets is made from ·5 to ·15 of the diameter of the equivalent cross-section. For multipolar types, in which the length of the magnets is of a comparatively much greater influence upon size and weight of the machine, it is customary to set the limit of the winding height considerably higher, in order to reduce the length necessary for the magnet winding. For cylindrical magnets to be used in multipolar machines, therefore, the practical limit of winding height ranges from ·75 to ·2 of the core diameter, and for rectangular or oval magnets from ·75 to ·25 of the diameter of the equivalent circular area according to the size.

In case of emergency the figures given for rectangular cores may be used in calculating circular magnets, or those given for multipolar types may be employed for bipolar machines.

In order to keep the winding heights within the limits given in Table LXIII., the lengths of cylindrical magnets have to be made from three to one times the core diameter for bipolar types, and from one to half the core diameter for multipolar types; those of rectangular magnets from one and two-thirds to three-quarters the equivalent diameter for bipolar types, and from one and a quarter to two-thirds the equivalent diameter for multipolar types; and the lengths of oval magnets, finally, from one and a half to three-quarters the diameter of the equivalent circular area for bipolar types, and from one and a quarter to five-eighths the equivalent diameter for multipolar types.

In the following Tables, LXIV., LXV., LXVI., LXVII., the dimensions of cylindrical magnet cores for bipolar types, of cylindrical magnet cores for multipolar types of rectangular magnet cores, and of oval magnet cores respectively, have been calculated. In the former two of these tables the lengths and corresponding ratios are given for cast-iron as well as for wrought-iron and cast-steel cores; in the latter two for wrought iron and cast steel only. From Tables LXIV. and LXV. it follows that cast-iron cores are made from 20 to 10 per cent. longer, according to the size, than wrought-iron or cast-steel ones of the same diameter; the lengths of cast-iron cores of rectangular or oval cross-section can therefore be easily deduced from the figures given in Tables LXVI. and LXVII.

TABLE LXIV.—Dimensions of Cylindrical Magnet Cores for Bipolar Types.

Total flux in webers.	Dimensions of magnet cores in inches.					
	Wrought iron and cast steel			Cast iron.		
	Diam. d_m	Length. l_m	Ratio $l_m : d_m$	Diam. d_m	Length. l_m	Ratio. $l_m : d_m$
70,000	1	3	3·0	1½	4½	3·0
150,000	1½	3¾	2·5	2¼	5¾	2·56
275,000	2	4½	2·25	3	7	2·33
425,000	2½	5	2·0	3¾	8¼	2·20
600,000	3	5¾	1·92	4½	9½	2·11
850,000	3½	6½	1·86	5¼	10¾	2·05
1,100,000	4	7½	1·87	6	12	2·0
1,700,000	5	9	1·80	7½	14¼	1·9
2,500,000	6	10½	1·75	9	16½	1·83
3,300,000	7	12	1·72	10½	18	1·71
4,500,000	8	13½	1·70	12	20	1·67
5,500,000	9	15	1·67	13½	22	1·63
7,000,000	10	16	1·60	15	24	1·60
8,500,000	11	17	1·55	16½	25½	1·55
10,000,000	12	18	1·50	18	27	1·50
15,000,000	15	22	1·46	22½	32	1·42
22,500,000	18	25	1·39	27	37	1·37
30,000,000	21	28	1·33	31½	41	1·30
40,000,000	24	31	1·29	36	45	1·25
50,000,000	27	34	1·26	—	—	—
60,000,000	30	36	1·20	—	—	—
75,000,000	33	38	1·15	—	—	—
90,000,000	36	40	1·11	—	—	—

TABLE LXV.—Dimensions of Cylindrical Magnet Cores for Multipolar Types.

Total flux per magnetic circuit in webers.	Dimensions of magnet cores in inches.					
	Wrought iron and cast steel			Cast iron.		
	Diam. d_m	Length l_m	Ratio. l_m d_m	Diam. d_m	Length. l_m	Ratio. $l_m : d_m$
275,000	2	2	1·00	3	3½	1·17
600,000	3	2¾	·92	4½	4½	1·00
1,100,000	4	3½	·875	6	5½	·92
1,700,000	5	4	·80	7½	6¾	·90
2,500,000	6	4½	·75	9	8	·89
4 500,000	8	6	·75	12	10½	·875
7,000,000	10	7½	·75	15	13	·87
10,000,000	12	9	·75	18	15	·83
15,000,000	15	11	·73	22½	18	·80
22 500,000	18	13	·72	27	20	·74
30,000,000	21	14½	·69	31½	22	·70
40,000,000	24	16	·67	36	24	·67
50,000,000	27	17	63	—	—	—
60,000,000	30	18	·60	—	—	—
75,000,000	33	19	·58	—	—	—
90,000,000	36	20	·56	—	—	—

(*b*) *Relative Position of Magnet Cores.*—The majority of types having two or more magnets, the relative position of the magnet cores is next to be considered. In a great number of forms having the magnets arranged symmetrically with reference to the armature circumference, the exact relative position of the magnet cores is given by the shape of the field-magnet frame. In other types, however, having parallel magnets on the same side of the armature, diametrically or axially, the shape of the frame does not fix their relative position, and the distance between them is to be properly determined.

This is done by limiting the magnetic leakage across the cores to a certain amount, according to the size of the machine—namely, from about 33 per cent. of the useful flux, in small machines, to 8 per cent. in large dynamos.

The relative amount of the leakage across the magnet cores is determined by the ratio of the permeance between the cores to the permeance of the useful path, and the percentage of the core leakage is kept within the limits given above, if the average permeance of the space between the magnet cores does not exceed one-third of the permeance of the gap space in small machines, and one-twelfth of the gap permeance in large dynamos, or if the reluctance across the core is at least three to twelve times respectively that of the gaps.

The area of the cross section and the length of the cores being given, the reluctance of the space between them depends upon the shape of their cross-section and upon the

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TABLE LXVI.—Dimensions of Rectangular Magnet Cores. (Wrought Iron and Cast Steel.)

Total flux per circuit, webers.	Cross-section.				Length.			
					Bipolar types.		Multipolar types.	
	Breadth, inches.	Width, inches.	Area, square inches	Diam. of equiv. circular area d_m.	Length l_m.	Ratio $l_m : d_m$	Length l_m.	Ratio $l_m : d_m$
500,000	2	3	6	2⅜	4½	1·64	3½	1·27
700,000	2	4	8	3 3-16	5	1·57	4	1·25
1,000,000	2	6	12	3 15-16	5½	1·40	4½	1·14
1,400,000	2	8	16	4½	6	1·33	5	1·11
1 200 000	3	4½	13·5	4 3-16	5½	1·31	4½	1·08
1 600,000	3	6	18	4 13-16	6¼	1·30	5	1·04
2,400 000	3	9	27	5⅞	7½	1·28	6	1·02
3,200,000	3	12	36	6⅝	8½	1·26	6½	·96
2,000,000	4	6	24	5 9-16	7	1·26	5¾	1 03
2,750,000	4	8	32	6⅛	8	1·26	6¼	·98
4,250,000	4	12	48	7⅞	9¾	1·24	7½	·95
5,500,000	4	16	64	9	10½	1·20	8½	·95
4,750,000	6	9	54	8⅜	10	1·20	8	·96
6,500,000	6	12	72	9⅝	11½	1·20	9	·94
9,500,000	6	18	108	11¾	13½	1·15	11	·94
12,500,000	6	24	144	13½	15½	1·15	12½	·93
8,500,000	8	12	96	11	13	1·18	10½	·96
11,000,000	8	16	128	12⅞	15	1·18	12	·94
17,000,000	8	24	192	15⅝	17½	1·12	14	·90
13,000,000	10	15	160	13⅞	16	1·15	12½	·90
17,500,000	10	20	200	16	18	1·12	14	·875
26 000,000	10	30	300	19½	20	1·03	16	·82
19,000,000	12	18	216	16⅝	18	1·08	15	·90
25,000,000	12	24	288	19⅛	20	1·05	16	·84
38 000,000	12	36	432	23½	22	·94	18	·77
30,000,000	15	22½	337·5	20¾	20	·96	17	·82
40,000,000	15	30	450	24	22	92	18	·75
50,000,000	15	37½	562·5	26¾	24	·90	19	·71
38 000,000	18	24	432	23½	22	·94	18	·765
47,500 000	18	30	540	26¼	24	·915	19	·74
57,000,000	18	36	648	28¾	25	·87	20	·70
55,000,000	21	30	630	28⅜	25	·85	20	·71
66,000,000	21	36	756	31	26	·83	21	·68
77,000,000	21	42	882	33½	27	·81	22	66
75 000 000	24	36	864	33⅛	27	·81	22	·66
90,000 000	24	42	1,008	35⅞	28	·80	23	·66
100,000,000	24	48	1,152	38¼	30	·785	24	·64

TABLE LXVII.—Dimensions of Oval Magnet Cores. (Wrought Iron and Cast Steel.)

Total flux per circuit, webers.	Cross-section.				Length.			
					Bipolar types.		Multipolar types.	
	Breadth, inches.	Width, inches.	Area, square inches	Diam. of equiv. circular area d_m.	Length l_m inches	Ratio $l_m : d_m$	Length l_m inches.	Ratio $l_m : d_m$
600,000	2	4	7·14	3	4½	1·50	3½	1·17
1,000,000	2	6	11·14	3¾	5¼	1·40	4¼	1·13
1,300,000	2	8	15·14	4⅜	6	1·37	5	1·14
1,400,000	3	6	16·06	4⅜	6	1·33	5	1·11
2,200 000	3	9	25·06	5⅝	7½	1·33	6	1·07
3,000,000	3	12	34·06	6⅝	8½	1·28	7	1·05
2 500,000	4	8	28·56	6	7¾	1·29	6	1·00
3,900,000	4	12	44·56	7½	9¾	1·27	7½	1 00
5,250,000	4	16	60·56	8¾	11	1·26	8½	·97
5,500,000	6	12	64·26	9	11	1·22	8½	·945
8,750,000	6	18	100·26	11¼	13	1·16	10½	·93
12,000,000	6	24	136·26	13⅛	15	1·14	12	·915
10,000,000	8	16	114·14	12	14	1·17	11	·92
15,000,000	8	24	178·14	15	16	1·065	13	·87
15,000,000	10	20	178·5	15	16	1·065	13	·87
24,000,000	10	30	278·5	18¾	20	1·065	16	·85
22.500,000	12	24	257	18	18	1·00	15	·835
35,000,000	12	36	401	22½	21	·93	17	·755
35,000,000	15	30	400	22½	21	·93	17	·755
55 000,000	15	45	625	28¼	25	·885	20	·71
50,000,000	18	36	578	27⅛	24	·885	19	·70
60,000,000	18	42	686	29½	25	·85	20	·68
70,000,000	21	42	787	31⅝	26	·82	21	·66
80 000,000	21	48	913	34⅛	27	·79	22	·645
90 000,000	24	48	1,028	36⅛	28	·78	22½	·625
100,000,000	24	54	1,172	38⅝	30	·78	24	·62

distance between them. In case of round cores the shape is given by the area of the cross-section, and the reluctance of the path from core to core in consequence only depends upon their distance apart, directly increasing with the same. The reluctance of the air-gaps is determined by the diameter and length of the armature, by the percentage of polar embrace, and by the radial length of the gap space, decreasing with the area of the gap and increasing with its length. The cross-section of the cores and the gap area both depending upon the output of the machine, have a more or less fixed relation to each other—varying with the type, the voltage, the speed, and the kind of armature—and the relation between the reluctance across the cores to that of the air-gaps can approximately be expressed by the ratio of the average distance apart of the cores to the radial length of the gap space. In dynamos with smooth-drum armature this ratio is made from 6 to 16, in smooth-ring machines from 8 to 20, and for toothed and perforated armatures the distance apart of the cores is taken from three to six times the maximum radial length of the gap space—*i.e.*, from three to six times the distance between pole face and bottom of armature slot. The following Table LXVIII. gives the average distance between cylindrical magnet cores for various kinds and sizes of armatures, the ratio of this distance to the radial length of the gap space, and the corresponding approximate leakage between the magnet cores, expressed in per cent. of the useful flux.

In case of inclined cylindrical magnets, the figures given in Table LXVIII. for the least distances apart are to be considered as the mean least distances, taken across the magnets midway between their ends. (Compare formula (131), chapter 39.)

In dynamos with rectangular and oval cores the leakage across, for the same distance apart, is greater than in case of circular cores of equal sectional area, increasing in proportion to the ratio of the width of the cores to their breadth. For rectangular and oval cores, therefore, the distance apart is to be made greater than for round cores in order to limit the leakage between them to the same amount, and the distance must be the greater the wider the cores are in proportion to their thickness. The following Table LXIX. gives the minimum, average, and maximum values of the ratio of the distance across rectangular and oval cores of various shapes of cross-sections to the distance which between round cores of equal sectional area effects approximately the same leakage in small, in medium-sized, and in large dynamos respectively :

TABLE LXIX.—Distance Between Rectangular and Oval Magnet Cores.

Ratio of thickness to width of cores.	Distance between rectangular and oval magnet cores as compared with that between round cores of equal area causing approximately the same leakage across.		
	Minimum (small machines).	Average.	Maximum (large machines).
1 : 1	1·0	1 0	1·0
3 : 4	1·05	1·07	1·1
2 : 3	1·1	1·15	1·2
1 : 2	1·15	1·22	1·3
1 : 3	1·2	1·3	1·4
1 : 4	1·25	1·37	1·5
1 : 5	1·3	1·45	1 6
1 : 6	1·35	1·55	1·75
1 : 7	1·4	1·65	1·9
1 : 8	1 5	1·75	2·05
1 : 9	1·6	1·9	2·25
1 : 10	1·7	2·1	2·5

In order to determine the proper distance apart of rectangular and oval magnet cores, the corresponding distance between round cores of equal cross-section is taken from Table LXVIII., in multiplying the radial length of the gap space by the ratio of distance apart to length of gap for the particular size of armature. The distance thus obtained is then multiplied by the respective figure found for the shape in question from Table LXIX.

50. *Dimensioning of Yokes and Pole-Pieces.*—(*a*) *Yokes.*—In bipolar types—the dimensions of the magnet cores being given by Tables LXIV., LXVI., or LXVII., Chapter 49, and their least distance apart by Table LXVIII., or LXIX., Chapter 49, thus fixing the length of the yoke, and the sectional area of the yokes being found from formula (137), Chapter 47—the dimensioning of the yoke consists in arranging its cross-section with reference to the shape of

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TABLE LXVIII.—Distance Between Cylindrical Magnet Cores.

Diameter of armature. Inches.	Smooth-core armature. Drum. Radial length of gap space.	Least distance between cores.	Ratio of distance apart to length of gap.	Approx. leakage between cores in p.c. of useful flux.	Ring. Radial length of gap space.	Least distance between cores.	Ratio of distance apart to length of gap.	Approx. leakage between cores in p.c. of useful flux.	Toothed or perforated armature. Max. radial length of gap space.	Least distance between cores.	Ratio of distance apart to max. length of gap.	Approx. leakage between cores in p.c. of useful flux.
	In.	In.			In.	In.			In.	In.		
2	11-32	2	5·8	33%	—	—	—	—	—	—	—	—
3	3·8	2⅜	6·3	30	—	—	—	—	—	—	—	—
4	7-16	3	6·9	25	5-16	2½	8·0	20%	11-16	2	2·9	15%
6	1-2	3⅝	7·5	22	11-32	3	8·7	18	13-16	2½	3·1	14
8	9-16	4½	8·0	20	3-8	3⅝	10·0	16	15-16	3½	3 5	13
10	5-8	5½	8·8	18	13-32	4⅜	11·7	14	1 1-16	4	3·8	12
12	11-16	7	10·2	16	7-16	5¼	13·1	12	1 3-16	4¾	4·0	11
15	3-4	8½	11·3	14	15-32	7	14·9	11	1 5-16	5½	4·2	10
18	13-16	10	12·3	12	1-2	8¼	16·5	10	1 1-2	6½	4·3	10
21	7·8	12	13·5	10	9-16	9½	16·9	9½	1 5·8	7½	4·6	9½
25	15-16	14	15	9	5·8	11	17 6	9	1 3-4	8½	4·9	9
30	1	16	16	8	11-16	13	18·9	8½	1 7-8	10	5·3	8½
40	1⅛	18	16	8	3·4	15	20	8	2	12	6	8

TABLE LXX.—Dimensions of Pole-pieces for Bipolar Horseshoe Type Dynamos.

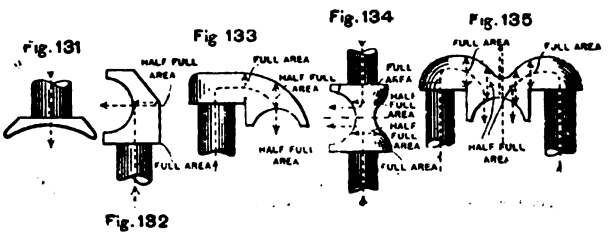
Capacity in kilowatts.	Drum armature. Average total flux of bipolar horseshoe drum type. Webers.	Diameter of armature. Inches.	Dimensions of pole-piece. Height. Inches.	Length. (= Length of armature.)	Thickness in centre. Inches. Wrought iron.	Cast iron.	Ring armature. Average total flux of bipolar horseshoe ring type. Webers.	Diameter of armature. Inches.	Dimensions of pole-piece. Height. Inches.	Area in centre. Wrought iron. Squareinches.	Cast iron. Squareinches.
·1	350,000	1⅜	2⅜	3½	½	1	175,000	4	4⅜	7/8	1⅜
·25	500,000	2¼	3	4½	1 5/8	1⅛	250,000	5	5⅜	1½	2½
·5	650,000	2⅜	3½	5¼	1⅜	1¼	325 000	6	6⅜	1 5/8	3¼
1	900,000	3¼	4	6	1⅝	1½	450,000	7	7¾	2¼	4½
2	1,400,000	3⅜	4½	7	1	2	675,000	8	9	3⅜	6¾
3	1,800,000	4⅛	5⅜	8½	1⅛	2¼	900,000	9½	10½	4½	9
5	2,500,000	5¼	6½	9½	1⅜	2⅝	1,300,000	11	12	6½	13
10	3,500,000	6	7	10½	1¾	3⅜	2,100,000	14	15	10½	21
15	5,000,000	6¾	7⅞	12	2⅛	4¼	2,800,000	15	16	14	28
20	6,000,000	7½	8⅝	13	2 5/16	4⅝	3 500,000	16	17	17½	35
25	7,000,000	8¼	9⅜	14	2½	5	4,200,000	18	19	21	42
30	8,000,000	9	10¼	15	2⅝	5⅜	4,800,000	20	21	24	48
50	12,500,000	10½	11⅝	18	3½	7	7,000,000	24	25	35	70
75	16,500,000	12½	13⅞	20	4⅛	8¼	9,500 000	28	29¼	47½	95
100	21,000,000	15	16½	22	4⅜	9½	12,000,000	32	33½	60	120
150	30,000,000	18½	20¼	26	5¾	11½	17,000,000	36	37½	85	170
200	38,000,000	22½	24½	31	6⅞	12¼	21,500,000	40	42	107½	215
300	57,000,000	28	30½	38	7½	15	30,000,000	46	48	150	300

the section of the cores, and, for the case that its material is different from that of the cores, in providing a sufficient contact area, conforming to the rules given in Chapter 46.

In multipolar types the total cross-section found for the frame from formula (137), Chapter 47, is to be divided by the total number of magnetic circuits in the machine and multiplied by the number of circuits passing through any part of the yoke in order to obtain the sectional area required for that part of the yoke, otherwise the above rules also govern the dimensioning of the yokes for multipolar machines.

(*b*) *Pole-Pieces.*—In dimensioning the pole-pieces three cases have to be considered: (1) the path of the lines of force leaving the pole-pieces has the same direction as their path through the magnets, Fig. 131; (2) the path of the lines leaving the pole-pieces makes a right angle to that through the cores, Fig. 132; and (3) the path of the lines leaving the pole-pieces is parallel but of opposite direction to that through the cores, making two turns at right angles in the pole-pieces, Fig. 133.

In the first case, Fig. 131, which occurs in dynamos of the iron-clad, the radial, and the axial multipolar types, the shape of the cross-section is fixed by the form of the magnet core at one end and by the axial length or the radial width of the armature respectively, and the percentage of polar arc at the other, while the



height in the direction of the lines of force is to be made as small as possible, in order not to increase the total length of the magnetic circuit more than necessary.

In the second case, Fig. 132, met with in bipolar and multiple horseshoe and in tangential multipolar types, the height of the pole-pieces is determined by the diameter, and the length of the pole-piece by the length of the armature, while the area of the cross-section perpendicular to the flow of the lines is to be made of the size obtained by formula (137) at the end next to the magnet core, and to be gradually decreased in amount from that end to the opposite end or to the centre of the pole-piece respectively, according to whether there is but one magnetic circuit or whether two circuits are passing through the same pole-piece. Since in bipolar machines the lines of force are supposed to divide equally between the two halves of the armature, only one-half of the total flux passes the centre of the pole-pieces in order to reach the half of the armature opposite the magnets, and the area in the centre of the pole-piece consequently needs to be but one-half that at the end next to the core. In case the two circuits passing through each pole-piece, Fig. 134, the same applies to the cross-section of the pole-piece at one-quarter the height from either end. For ready use in Table LXX. the dimensions of wrought and cast iron pole-pieces for various sizes of bipolar horseshoe type dynamos are calculated for drum and ring armatures by combining the respective data given in former tables.

In the third case, Fig. 133, finally, which is found in single and double magnet types, the length of the magnetic circuit in the pole-piece is determined by the diameter of the armature, by the cross-section of the magnet core, and by the height of their winding space; the width parallel to the armature shaft of the pole-piece near the magnet is given by the width of the magnet core, and that near the armature by the axial length of the latter. The heights parallel to the axis of the magnet core, in case of a single circuit, are to be so chosen that all of the cross-sections up to that in line with the pole corner next to the magnet core have an area at least equal in amount to that obtained by formula (137), and that the section in line with the armature centre has an area of one-half that amount. In case of two circuits meeting at the pole-pieces (consequent-pole types), Fig. 135, the full area has to be provided from either end of the pole-piece to the sections in line with the pole corners, half the full area at quarter distance from each pole corner—that is, midway between each pole corner and the pole centre—and sufficient cross-section for mechanical strength only is needed at the centre of the pole-piece.

(To be continued.)

THE HOLOPHANE GLASS GLOBES.

These light dispersing and directing globes, manufactured on the Blondel and Psaroudaki system, are being introduced into this country by Mr. S. M. Scott. There is no point in the construction or principle of these globes which has not been understood for years, but by careful work on proved

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theoretical lines a practical globe has been produced which gives most excellent results. The history of light-diffusing globes for arc and incandescent lamps is too extensive to be gone into here, but it has received a fair amount of attention in England.

The inventors of this new globe state that the great fault of the older dispersing globe was that a certain percentage of the light was turned back into the interior again by certain parts of the surface of the globe. This is illustrated in Fig. 1, where the ray of light striking on the

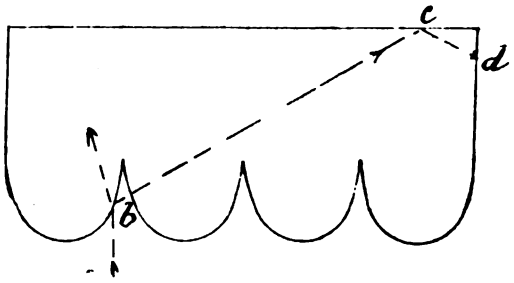

FIG. 1.—Old Type of Light Dispersing Flutings.

side of the V is reflected, and again refracted from the outer surface of the glass. In this way the light does not get out through the glass, as it should do. To get over this, Messrs. Blondel and Psaroudaki have abandoned the sharp angle at the bottom of the fluting, and use a concave flute instead. The pitch of fluting is smaller

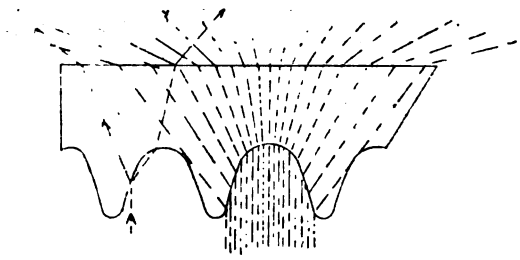

FIG. 2.—New Dispersing Flutings used in the Holophane Globe.

than that used in older forms of dispersing globes, and they endeavour to design the contour of this fluting so that none of the light is reflected or refracted internally. They have adopted a form of contour as shown in Fig. 2. This dispersing fluting is arranged on the inside of their globes. The next point is that they use the principle of

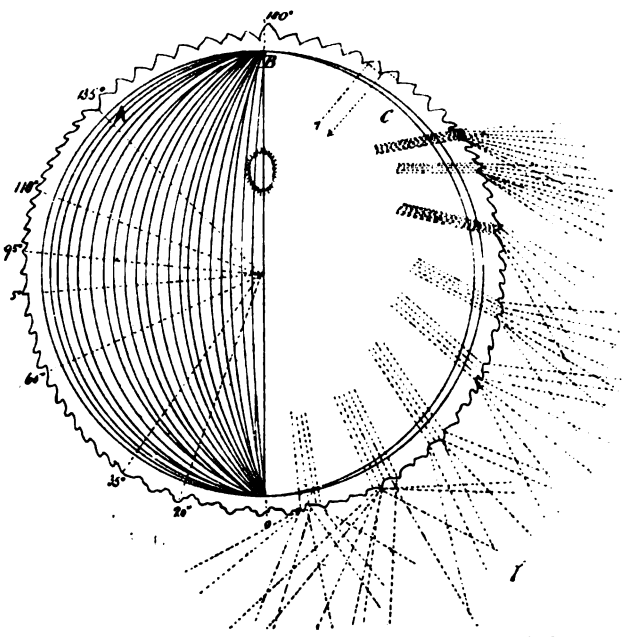

FIG. .—Section of Arc Lamp Globe showing Different Shaped Flutings.

the Fresnel lens system for the purpose of directing the light externally. To this end a series of horizontal flutings are made round the outside of the globe. The form of the fluting changes at different parts of the globe, so that each corrugation throws the light in approximately the same direction.

We had not the opportunity of testing one of these globes round an arc light, but on a high candle-power incandescent lamp the effect was most satisfactory. The upward rays from the lamp were practically all reflected downwards by the upper surfaces of the fluting, so that the ceiling above the globe was darker than any other surface in the room. When looked at from underneath the whole of the globe was lighted, and the great number of brilliant facets had a most pleasing effect. Tests made in Paris at the Central Laboratory of Electricity showed that the globes absorbed only from 9 to 13 per cent. of the light passing through them, and these figures are confirmed by tests made by the Edison Company in Paris.

The way in which the arc lamp globes improve the polar curves of candle-power has been shown by this last-named company from tests made on lamps placed in the Boulevard St. Denis, in Paris. The actual curves show that the globes have been accurately designed, with the object of giving as uniform distribution as possible over the space intervening between two arc lamps. The angle of maximum candle has been considerably elevated to this end.

The important question of manufacturing these globes and shades commercially to compete with existing types precluded the use of cut glass. After careful trials, the

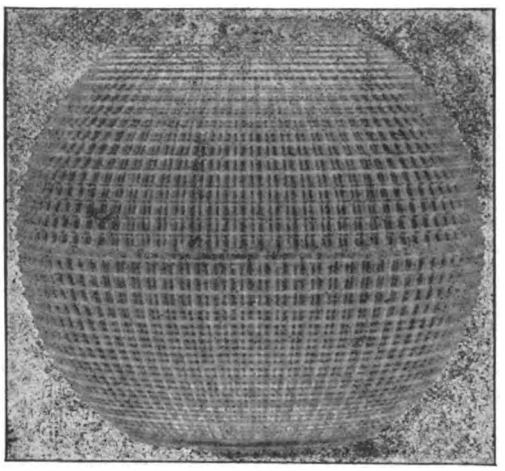

FIG. 4.

inventors have succeeded in getting their globe produced in pressed glass. The first cost of the necessary moulds having the different-shaped grooves is, of course, great, but this factor disappears when the globes are manufactured in quantity.

We illustrate a section of the arc lamp globe, Fig. 3, which shows the different forms of the fluting at different parts of the globe, and also indicates the transmitted and refracted rays of light. Fig. 4 gives the general appearance of this globe.

We understand from Mr. Scott that the globes will be placed on the market early in May at prices which should command business, and are sure he will be pleased to show them to anyone interested in the subject at his office at 35, Queen Victoria-street, E.C.

Electric Traction in France.—An electric railway is to be constructed from the Carrefour Cadet to the summit of Montmartre.—The report of the Continental Metropolitan Tramways Company, Limited, for 1894 states that the necessity for improving the means of communication in Paris has long been felt, but it has become much greater by the rejection of the scheme for a metropolitan railway, and in view of the approaching Universal Exhibition in 1900. There has consequently been a general movement amongst the tramway and omnibus companies in Paris for new lines, extensions, and improved methods of traction. The directors have, in accord with their Paris colleagues, decided that the interests of the company demanded the adoption of a similar policy. With reference to the substitution of mechanical for horse traction, this question is receiving the fullest attention of the directors.

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THE LIGHTING OF RAILWAY CARRIAGES.

The most interesting paper recently read by Mr. W. Langdon before the Institution of Electrical Engineers did not, as was hoped, touch on this most important question. We cannot deny that during the past few years great improvements have been made by railway engineers in the lighting of the trains under their charge, but unfortunately their efforts have in most cases been confined to main-line and express carriages. The class of passenger so catered for is an important one, and on a long journey the need of a good light is specially felt. Still, this is no reason why the needs of the local and suburban lines, which carry, perhaps, a hundred passengers while the main lines carry one, should be so neglected. After a busy day in town the light provided in the carriages of many of the local lines round London is irritating in the extreme. We usually find just enough light to read the headings of the articles in the evening papers, and that is all. At the stations you may stop just opposite a ten-candle-power gas lamp, which for the time being dims the internal lighting of the carriage and enables you to read a short way into an interesting article, which may, perhaps, be "continued at the next" station if the fates are propitious.

We do not doubt that the directors are more to blame than the engineers, but it is to the engineers that we must look for improvements. The fact that comfort in travelling leads to increase of traffic more than compensating for the cost of such extra comfort has been abundantly proved. In America, the great development of the tramway industry there following on the improved speeds gained by electric traction over horse traction, is a most remarkable instance of this. We do not suppose any "radical reduction" railway director would deny that the main-line traffic has been increased owing to improvements in speed, lighting, and general comfort, and yet he would continue to run antiquated carriages with one-candle-power oil lamps on local lines, which, as a rule, pay better dividends than main lines.

The question as to what is the best system of lighting for railway carriages from the directors' point of view we do not propose to discuss *in extenso* here, as we know that electricity is the best and safest illuminant for the purpose. We believe that it will prove also to be much the cheapest, light for light, when worked on a large scale. Still, we contend that even should it be dearer than other illuminants which are dangerous to the public safety and health, it will still more than pay for its cost by the additional comfort it gives. We honour the English railway engineers who have taken such a prominent lead in the development in the electric lighting of trains so largely in America. Amongst these we may specially mention Mr. E. J. Houghton, Mr. W. Langdon, and Mr. Ireland, all of whom have given much time and original thought to this subject. Others have ably assisted in the progress made. Nearly all the engineers in England have driven their dynamos from the axles of the guard's van. We are sure they have not done so on account of the popular idea

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that it costs nothing for coal if so arranged, but the great advantage of this system is that on down grades the momentum of the train provides the necessary energy.

The great variation in speed has to be corrected by some device to ensure constant potential at the lamps. The many ingenious inventions with this object will form the matter of a series of articles commencing in this issue.

Other electrical systems have been tried in this country and elsewhere. We have full confidence that both the cost of upkeep and the capital charges will be considerably reduced in consequence of this competition, and that at least even the shareholders, who desire dividend before everything else, will be obliged to admit that electricity is the best light, the cheapest light, and the light they will have used on the lines in which they are interested.

THE ST. PANCRAS REPORT.

Although the representative committee of experts have given us some definite information as to the probable source of the alkaline deposits in the St. Pancras conduits, we regret that they have not given a more exhaustive report before concluding their labours. The fact that no free alkali was found in any of the samples submitted to Prof. T. E. Thorpe is of itself a curious admission in a report which attributes the explosion to the very substance their chemical expert did not find. Personally, we have no doubt but that such free alkalies have been found quite recently at St. Pancras, and why such samples should not have been immersed in oil and preserved for analysis we cannot understand. From a wood bearer which we have permitted to inspect through the courtesy of Mr. J. T. Baron, we have no doubt but that the greater portion of the alkaline deposit originates from the soil being introduced along the fibre of the wood in solution. Still, beside this, the glaze shows signs of disintegration, and is, we believe, a contributory cause. In fact, we understand that Prof. A. B. W. Kennedy has for years avoided the commercial glazes for this reason, and specifies that all earthenware used in the construction of his mains shall have a hard insoluble glaze. This precaution, although it may raise the price of the insulators slightly, will prevent any trouble arising from them. In conclusion, we can only repeat that a report on this most important subject consisting only of some two hundred words, is not what we should expect from a committee representing such wide interests.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ALKALINE DEPOSITS ON ELECTRIC LIGHT MAINS.

SIR,—We have read with interest the report by the special committee formed to investigate the cause of the alkaline deposit found on the electric light mains at St. Pancras. Several articles have appeared in the electrical journals attributing this deposit to the decomposition of the stoneware insulators. We fear that the tendency of such articles unfortunately may have been to create a want of confidence in a material very reliable and suitable for insulating purposes. We think it therefore of great importance that attention should be called to the finding of the committee of investigation, which proves conclusively that the deposit (which has been found on glass, brickwork, and wood, as well as on stoneware) is not derived from the insulators, and which entirely confirms the view we took in a recent letter to one of your contemporaries, in which we asked that "before the presence of the unwelcome sodium is attributed to 'decomposition of stoneware' those interested in the result should wait to see whether the investigation may not prove that the source is to be found, not in the insulators, but in the cement, the brickwork, or the surrounding soil."—Yours, etc.,

DOULTON AND CO.

Lambeth Pottery, London, S.E., April 17, 1895.

COST OF ARC LIGHTING.

With reference to our leader last week on this subject, we have had a communication from Mr. Raworth informing us that 2½d. per arc lamp hour was the price obtained from the North-Western Railway Company for lighting their Manchester station. We cannot remember at this distant date the actual cost of production.

WHAT, WHEN, AND WHERE.

Royal Institution, Albemarle-street, Piccadilly, W.

April 23, 3 p.m.—The first of a course of three lectures on "Alternating and Interrupted Electric Currents," by Prof. George Forbes, M.A., F.R.S., M.I.C.E.

Institution of Civil Engineers, 22, Great George-street, S.W.

April 19, 2.30 p.m.—Students' visit to the Lion Brewery, 51, Belvedere-road, Lambeth, S.E.

Institution of Electrical Engineers.

April 25, 8 p.m.—At the Society of Arts, John-street, Strand. "A Magnetic Tester for Measuring Hysteresis in Sheet Iron," by Prof. J. A. Ewing, M.A., F.R.S.

Institution of Mechanical Engineers.

April 24, 7.30 p.m.—At the Royal United Service Institution, Whitehall. Discussion on Captain H. Riall Sankey's paper on "Steam-engine Governing." Followed, if time permits, by Prof. W. C. Roberts-Austen's third report to the Alloy Research Committee.

April 25.—Annual Dinner.

April 26, 7.30 p.m.—Discussion on the above paper.

Corporation of Leicester.

April 25, 12 noon.—Opening of Electric Light Station by Alderman Lennard, followed by a luncheon at 1 p.m.

Sanitary Institute, Parkes Museum, Margaret-street, Regent-street, W.

April 19, 8 p.m.—"House Drainage," by W. C. Tyndall.

April 20.—Inspection and Demonstration of the Barking Sewage Outfall Works, conducted by J. E. Worth, M.I.C.E.

April 23, 8 p.m.—"Sewage and Sewage Disposal," by Prof. H. Robinson, M.I.C.E.

April 24, 3 p.m.—Inspection and Demonstration of the Disinfecting Station at St. Pancras.

Society of Arts, John-street, Adelphi, Strand.

April 22, 8 p.m.—Cantor Lecture by James Douglas on "The Recent Metallurgy of Copper, Lead, Gold, and Silver in America."

April 24, 8 p.m.—"The Use of Electricity for Cooking and Heating," by R. E. Crompton, President of the Institution of Electrical Engineers.

April 25, 4.30 p.m.—"The Coming Railways of India, and their Prospects," by J. W. Parry, A.M.I.C.E.

Croydon County Polytechnic, Scarbrook-road, Croydon.

April 20, 8 p.m.—"The Applications of Electricity," by A Scholey.

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CITY AND GUILDS OF LONDON INSTITUTE.

ANSWERS AND SOLUTIONS TO THE QUESTIONS IN ELECTRIC LIGHTING AND POWER TRANSMISSION.

PRELIMINARY EXAMINATION, 1894.

1. Define the terms "in parallel," "in series," "on open circuit," and give sketches in illustration.

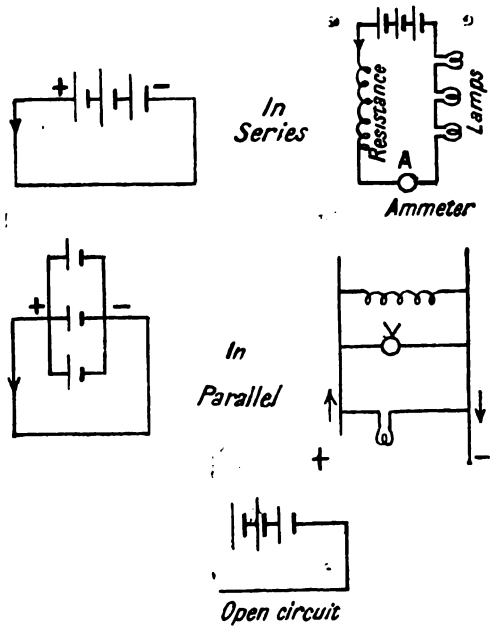
Answer 1.—The path traversed by an electric current is called an electric circuit, and it is obvious that it must at least be composed of two parts—*i.e.*, (1) the source, and (2) a conductor connecting the terminals of the source. Now, each of these parts may be composed of one or more separate parts. For instance, the source may consist of several cells and form a battery, whilst the conducting portion may include connecting wires, measuring instruments, and appliances worked by the current, and the terms "in parallel" and "in series" are used to indicate the methods of joining up the separate portions composing the circuit, according to the conditions of the case.

"In parallel" is defined as that arrangement in which all similar ends, terminals, or poles of the elements are connected to one conductor, and the other ends of the elements are connected to another conductor, so that the circuit is composed of several separate paths.

"In series" is defined as that arrangement in which the positive terminal of an element is connected to the negative terminal of the next element, and so on, so that the whole thus connected forms a series of parts, through which the same current passes.

"Open circuit" is defined as that arrangement in which the current is not able to pass into the conducting part of the circuit.

In the figures below the parallel lines represent graphically a battery; the short thick lines denote the zinc plates, and the long thin lines the negative plates.

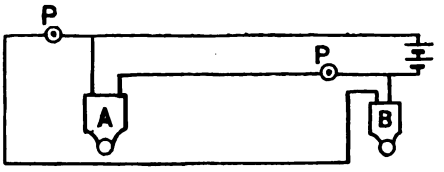


2. Describe the Leclanche cell, and add some hints as to how to maintain it in working order.

Answer 2.—The Leclanché cell is a zinc-carbon couple, the positive plate of which consists of a rod of amalgamated zinc, and the negative plate consists of a plate of carbon, which is fixed in a mixture of powdered peroxide of manganese and carbon, placed in a jar of porous earthenware. The two plates are placed in a glass vessel containing a saturated solution of chloride of ammonium (sal-ammoniac). In consequence of polarisation, which is very rapidly produced, the current is only continuous for a very short time, so that this cell is particularly well adapted for intermittent work, such as bell ringing. If allowed to rest, however, it soon regains its activity and strength, and as it does not deteriorate much when on *open circuit*, it will last for months without attention and renewal. Its E.M.F. is about 1·47 volts, and its resistance fairly high.

To maintain the cell in good working order it is necessary to add water from time to time in consequence of evaporation. Sal-ammoniac must also be added occasionally, as there is a tendency for the sal-ammoniac to gradually crystallise out and to creep up the sides of the containing vessel. For this reason it is advisable to cover the inside of the neck of the containing jar with melted paraffin wax. It should be kept in a cool, dry place.

3. Sketch the connections needful for bells between two places, A and B, so that a person at B can ring the bell at A, and that a person at A can ring the bell at B. One battery (of two or three cells) only to be used, and only one bell to ring at a time.



4. A lamp circuit is supplied at a pressure of 100 volts. There are 42 lamps, all in parallel, and the resistance of each lamp is (when hot) 150 ohms. How much current will the circuit take when all the lamps are on?

Solution.—Resistance of 42 lamps in parallel $= \frac{150}{42}$ ohms.

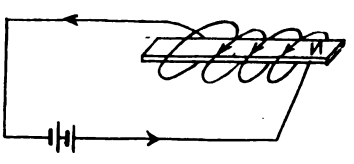
By Ohm's law $C = \frac{E}{R}$

$$= \frac{100 \text{ volts}}{\frac{150}{42} \text{ ohms}} = 100 \times \frac{42}{150} = 28 \text{ amperes.}$$

Answer.—28 amperes.

5. How can you convert a bar of iron into a magnet? If you have a small E.M.F., and no appreciable resistance in the rest of the circuit, would you use thin wires, or thick, for winding an electromagnet?

Answer 5.—Generally speaking, a bar of iron is magnetised when placed in a magnetic field, and since a very uniform field is produced in the interior of a spiral coil of wire through which a current circulates, a very convenient method of magnetising a bar of iron is to insert the iron into a hollow solenoid whilst the current is passing. This last condition is necessary, since the iron is a magnet only so long as the current is passing. The following sketch depicts the arrangement, and indicates the polarity of the bar when magnetised. The direction in which the current circulates decides which end is N.



In circuits with small E.M.F.'s, and an electromagnet forms one part of the circuit, then the resistance of the wire on the electromagnet should be of similar magnitude to that of the rest of the circuit; consequently, in the case under consideration thick wires should be used.

6. If electric bells are to be made to ring (by a magneto-ringer) through a line many miles in length, why must fine wire be used, both in the coils of the ringer and in the coils of the electromagnet in the bell?

Answer 6.—In telegraphic work the currents used are extremely small, as the resistance of the circuit is fairly high. Consequently, to get the required magnetising effect with the electromagnet, it is necessary to have a very large number of turns wound on the bobbins, and as fine wire will comfortably carry the small current, and at the same

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time allow a large number of coils to be wound in a small space, fine wire is always used. In such cases as this, the battery is replaced by a small magneto dynamo, the armature of which is constructed so that the E.M.F. set up in it (when rotated) is fairly high—in fact, it must be sufficient to send the current through the high resistance of the circuit. This is accomplished by winding the armature coils with a large number of turns of fine wire. It should also be noted that when the resistance of one part of a circuit is high, as in the case of a line many miles in length, the resistance of the remaining part of the circuit should also be high.

7. Why is there a permanent steel magnet in the bells that are to be used with magneto-ringers?

Answer 7.—In magneto-ringers, a permanent magnet, in addition to an ordinary electromagnet, is employed, so as to secure unidirectionality of motion. If the armature of an electromagnet be soft iron, then attraction takes place whichever way the current circulates round the electromagnet, and if the current be rapidly and repeatedly reversed, the armature is still pulled. Now, in magneto-ringers, alternating currents are used, consequently the armature will remain stationary if made of soft iron, whilst if it be permanently magnetised it will oscillate to the right and left alternately; and as it is pivoted it throws the little hammer to and fro between two bells, the movements corresponding perfectly to the directions of the currents.

8. Describe shortly the construction of a glow lamp. Why does the filament become hotter than the platinum leading-in wires? Why does the globe of a bad lamp get very hot?

Answer 8.—A glow lamp is one in which light is produced by the passage of a current through carbon fixed in a vacuum. The parts of a glow lamp are:

(1) Carbon filament; (2) sealed and exhausted glass globe; (3) two leading-in wires of platinum; and (4) a base providing means of supporting the lamp and of making contact with the circuit.

The construction of such a lamp consists of three processes:

(1) *The Manufacture of the Filament.*—A satisfactory filament must be a bad conductor of electricity, and be practically infusible, and no substance supplies these qualities to the same degree as carbon. A thread or fibre of a suitable material, containing a large proportion of carbon, is prepared to the proper size and shape and then subjected to the action of a high temperature, whilst surrounded with a highly carbonaceous substance out of contact with the atmosphere. This process is known as carbonisation, and is continued until the filament is homogeneous in structure throughout.

(2) *Connecting to the Leading-in Wires.*—These are platinum; this metal being chosen because its melting point is high, and it may readily be fused in glass if necessary. The leading-in wires are connected to the filament by means of a carbon cement, or a deposit of carbon made over the junction, or by riveting. The leading-in wires are then fused in the glass globe, or permanently fixed in the base by means of a non-conducting cement. In the first method the platinum wires terminate in loops; in the other, the ends of the platinum wires are connected to pieces of brass to which connection is made with the external circuit. The filament thus fixed is then flashed. The filament is heated to a dull red by a current, and then surrounded by an atmosphere of hydrocarbon gas, which is decomposed, and a very dense deposit of carbon is made on the filament. This makes the filament more uniform.

(3) *The Production of the Vacuum.*—The filament is then fixed in a glass globe, which is exhausted of air by means of a vacuum pump, after which the globe is hermetically sealed, and the lamp is ready for use.

As is well known, the heating effect of a current is proportional to the square of the current passing and to the resistance of the conductor, and in all systems of electric lighting the principle adopted is to concentrate the resistance of a circuit at certain points where light is desired, and it is at such points where the heating effects are manifested; and since the resistance of the carbon filament is much greater than the resistance of the platinum leading-in wires, the former gets much hotter than the latter.

The quality of a lamp depends to a great extent on the degree of exhaustion of the lamp bulb. A bad lamp may be caused by only partial exhaustion, and in such cases the molecules of the air remaining in the globe will by *convection* remove a quantity of heat from the filament and give it to the glass, which in consequence becomes hot.

9. How many horse-power is required to drive a current of 100 amperes through a resistance of 7½ ohms?

Solution 9.—One horse-power is equivalent to 746 watts, and one watt is the power absorbed in a circuit when one ampere flows through it under a pressure of one volt;

$$\therefore W \text{ (watts)} = E \text{ (volts)} \times C \text{ (amperes)}, \text{ and } E = C \times R.$$

By Ohm's law,

$$\therefore W = C^2 \times R = 100 \times 100 \times 7{\cdot}5 = 75{,}000 \text{ watts};$$

$$\therefore \text{H.P.} = 75{,}000 \div 746 = 100 \text{ h.p (approximately)}.$$

10. State the principles on which the Cardew voltmeter is based.

Answer 10.—(1) *The heating effect of a current.* This voltmeter usually consists of a platinum-silver wire 13ft. long and 0·0025in. in diameter, and as the wire is very thin it very readily acquires the temperature corresponding to the particular current passing along the wire. The current passing is a measure of the E.M.F. between the terminal of the instrument. (2) *The expansion of a wire due to the rise of temperature produced by the current.* The elongation is proportional to the increase in the temperature, and the movement this elongation gives to a pointer is increased by a multiplying gear.

11. Name the principal parts of an arc lamp, and say what is the use of each part.

Answer 11.—(1) *Carbon pencils* of a very dense and homogeneous nature, made of coke carbon. When two carbon pencils are placed in contact, and a current of 10 to 15 amperes at a pressure of 40 to 50 volts is sent through them, the junction very soon becomes red hot, and Davy found that by separating the carbon about $\frac{1}{10}$in. a very brilliant white light was produced. When in use the carbons are gradually consumed. (2) *The arc.* The bright light just mentioned is produced by the spark which passes when the carbons are separated, and this volatilises a small quantity of carbon between the pencils. This carbon vapour has a very high resistance, but the E.M.F.'s employed are sufficient to send a current through it, with the result that the gap is raised to a high state of incandescence, forming an arch or bridge which is termed the voltaic arc. (3) *Feeding mechanism.* As the carbon pencils are gradually consumed some automatic arrangement is required to maintain a constant distance between the points, which is termed the feeding mechanism. In some lamps the mechanism consists of clockwork regulators, in others solenoids, brake-wheels, clutches, and motors are used. Whatever the arrangement may be, it should also *strike* the arc at the beginning.

12. Define "work" and "power." How many foot-pounds of work will be done in 20 minutes by a motor working at 4 h.p.?

Solution 12.—"Work" is done when force is overcome through a distance.

"Power" is the rate of doing work—*i.e.*, the work done in unit time.

$$4 \text{ h.p.} = 4 \times 33{,}000 \text{ foot-pounds per minute};$$

$$= 132{,}000 \quad \text{,,} \quad \text{,,} \quad \text{,,}$$

$\therefore$ in 20 minutes the amount of work done $= 20 \times 132{,}000$ foot-pounds $= 2{,}640{,}000$ foot-pounds.

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REDUCING THE COST OF ELECTRIC LIGHT.*

BY NELSON W. PERRY.

It is so easy to prove on paper by means of apparently legitimate assumptions that the electric light can be made to sell at a considerable profit at a figure which is but a fraction of that usually charged that the public has been easily convinced that a bonanza attended the procurement of an electric lighting franchise in almost any municipality. The rude awakening to the investor when the annual statement has shown a balance on the wrong side of the ledger, in the face of the brilliant promises held out by lead-pencil prophecies, has too often come as a shock for which there seemed no other explanation so ready as that of wilful misrepresentation and dishonesty. The electric lighting industry has, therefore, suffered in reputation to such an extent as to make it difficult at the present day to float enterprises even of the most legitimate character. That dishonesty or incompetency has too often been charged where it did not really exist can readily be proved by figures from actual practice which show shortcomings in the performance of machinery that even central-station managers are only now beginning to realise.

A year ago the committee on data of the National Electric Light Association reported data of coal consumption per indicated horse-power in a large number of central stations, which attracted wide attention at the time, as indicating poor engineering practice. It was stated that with a consumption of 1·5lb. of coal per indicated horse-power, with a combined engine and dynamo efficiency of 81 per cent., a production of 402·84 watt-hours per pound of coal would result. This was equivalent to ·54 e.h.p. per pound of coal, or, in other words, an electrical horse-power could be generated for one hour on a consumption of a trifle over 1lb. of coal. The assumptions on which this statement was based seem entirely legitimate, since engines of a guaranteed efficiency of 90 per cent. and dynamos of an efficiency of 95 per cent. are readily obtained in the market, and it is not unusual to find a combined efficiency, under test conditions, of 85 per cent. These being facts, it was with considerable surprise to many that the results of actual practice were announced. The highest results given were 208 watt-hours per pound of coal. The next highest was 192, the lowest 25, and the average 91·7 watt-hours, or only 22·7 per cent. of that which was attainable by the best practice. In other words, the average central-station practice required 8lb. of coal to produce the same amount of electrical energy that machinery readily attainable was capable of producing on a consumption of 1·8lb.

This was a showing so unfavourable to electrical engineering practice as to cause considerable comment in the electrical journals and lead to some question as to the correctness of the figures. An average of data picked up haphazard, however, is not to be taken as a fair average of practice, and, since lower averages in efficiencies are to be expected in small stations where the units employed are small than in larger ones where apparatus of the highest refinements and possibilities are the rule, I discarded the reports from all stations consuming less than 10,000lb. of coal per 24 hours, and, averaging those above this, found a result of 127·7 watt-hours per pound of coal, or a consumption of about 5lb. of coal per electrical horse-power hour. This was a result which in ordinary steam practice would be poor even with small non-condensing engines, and yet undoubtedly most of the engines employed in the works whose results were considered were large compound engines, double or triple expansion and condensing.

At first blush these figures would seem to imply something radically wrong, and it was but natural to turn to foreign practice to see how it compared with ours. Such a reference shows that in the best English central stations the discrepancy between what ought to be and what is is even greater than in this country. Prof. Unwin is authority for the statement that probably the consumption (in England) has in no case been less than 3·3lb. of coal per indicated horse-power. This, with the assumed efficiency of 81 per cent. for engine and dynamo, would be equivalent to 4lb. of coal per electrical horse-power, and reports from several of the large London stations show a consumption of from 6lb. to 8lb. or more.

It was some satisfaction to find that American practice was at least no worse than that of our cousins across the water, who pride themselves upon greater refinements in engineering detail than we possess.

This same committee on data had been continued, and during the past year had been engaged in collecting further facts in regard to central-station economy, and their report, which was made at the Cleveland Convention last February, was awaited with considerable interest.

This report embraced data from 24 central stations, among which were several of the largest in the country—17 of which exceeded 10,000lb. of coal consumption per day. The average consumption of coal for all of those reporting was 127·7 watts per pound of coal, or 5·8lb. of coal per electrical horse-power hour. Taking, as before, only those stations consuming more than 10,000lb. of coal per day, we find the average to be 5·79lb. per electrical horse-power hour, which is a better showing for the average of all reporting, but not so good a showing for the average of those stations consuming in excess of 10,000lb. of coal per day. A very marked advance was shown, however, in this report in a single instance, which reported a total daily output of nearly 23,000,000 watts per day on a consumption of 87,358lb. of coal, which is equivalent to a consumption of a little more than 2·84lb. per electrical horse-power hour. This particular station, however, was the only one doing better than 4·11b. of coal per electrical horse-power hour, whereas in one case the consumption was as high as 24·8lb., and there were six reporting more than 7lb.

These figures are startling, and at once suggest the enquiry as to the cause of these low results. The answer cannot be more completely given than by quoting from some tests made by Prof. Kennedy at the Millbank-street station of the Westminster Electric Supply Corporation. Dividing the day into three portions, he determined the fuel consumption and the electrical horse-power developed during each period as follows:

TABLE OF COAL CONSUMPTION IN BOILERS WITH VARIABLE LOAD.

	11 a.m. to 6 p.m. 7 hours.	6 p.m. to midnight. 6 hours.	Midnight to 11 a.m. 11 hours.
Total i.h.p. hours	562	1,366	407
Total e.h.p. hours	400	979	280
Coal per i.h.p. hour, lbs.	6·88	3·26	6·26
Coal per e.h.p. hour, lbs.	9·67	4·55	9·80

This table shows very clearly the effect of light load upon coal consumption on engines of the same class, and although the best figures given—4·55lb. of coal per electrical horse-power hour, while the machinery was operating at its largest load—leave much to be desired, it is shown that even these are doubled during the hours of light load. They show unmistakably that at least one prolific cause of lack of economy in central-station practice is the extremely variable load to which the central lighting station must cater, and when we consider that even in New York City at least 2½ times as much machinery must be installed as could, if working continuously, produce the same gross output, we see another cause of expense in the way of interest and depreciation charges which in the lead-pencil estimates are apt not to be considered, or at least to be insufficiently provided for.

In fact, that these increased costs due to variable load are not well understood even by those presumed to be fairly well posted was well illustrated by some editorial comments in one of our leading engineering magazines upon some figures given by the author, which assumed the coal consumption per electrical horse-power hour under the conditions of continuous operation at 2·21lb., and that under ordinary conditions of practice at 4lb., the disparity being characterised as absurd. It seemed to me, therefore, probably not uninteresting to lay the facts before the public, who may not be expected to be so well posted as editors in general are supposed to be.

But while the item of fuel is an important one in the cost of electrical energy, it is by no means the only one which is seriously affected by the variable character of the

* From the *Engineering Magazine*, New York.

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central station. I have already referred to its effect upon interest and depreciation charges, and these may in some cases become more important than the fuel charges. It is these that so often render the employment of water powers uneconomical, and which must militate so largely against the economical results from the great Niagara electrical power scheme. The most noteworthy electrical power transmission scheme that has thus far been tried was that of the Lauffen experiment in 1891, in which some 300 h.p. were transmitted electrically from the falls of the Neckar at Lauffen to the Frankfort Electrical Exposition grounds—a distance of 108 miles. Technically this was a great triumph, the efficiency of transmission having been about 75 per cent. Commercially, however, it was a failure, since the power cost, when delivered, five times as much as it could be produced for locally by means of steam. Thus we see how enticing water-power projects often fail commercially, independently of fuel charges or apparatus efficiency, but through exorbitant fixed charges incurred in rendering available what would otherwise prove a cheap source of energy.

There is also a popular misconception as to the relative costs in distribution of energy by different methods. Probably nine out of every ten to whom the question was propounded would answer unhesitatingly that energy for lighting purposes could be delivered more cheaply at a distance by electrical means than by means of gas transmission, and under some conditions this is true; but I find by calculation that if the distance involved were a mile, it would require considerably more metal to supply the electric lights by means of the direct current than would be required for pipes to convey a supply of gas for the same number of lights with the same efficiency of transmission.

The bane to the electric lighting industry is therefore the peculiar service which it is required to supply, reaching a very high maximum for a very few hours, and then descending to a very low mean, during which time the apparatus has but small earning capacity, and that portion which is not lying totally idle is producing energy at an uneconomical rate.

Could the central-station apparatus be kept in operation continuously at its most efficient output, the electric light could be sold to consumers at a considerable discount upon the price of gas, and still net the manufacturer a larger profit than the gas-man realises, and this without any change in apparatus or methods of distribution from those now in vogue.

The gas manufacturer, though he have exactly the same service to meet as the central-station manager, is not handicapped by the irregularity of this service, in that he can store up the product which he has to sell when the product is greater than the demand, and draw upon this store during the hours when the demand exceeds the supply. He need only supply sufficient apparatus to meet the average demand, and this, being kept in continual operation at its most efficient rate, earns to its fullest extent for every hour in the day. The central-station manager, on the other hand, has no method of storing up the product which he has to sell. If he employ storage of any kind at any stage of the manufacture, it introduces additional transformations of energy which not only are apt to be expensive in themselves, but also involve necessary losses in final output, which must be balanced against any economies which they may present.

It is natural, therefore, that relief should be sought rather in increasing the regularity of the demand than in these methods of storage; but here, too, difficulties present themselves which have not as yet been obviated. In the first place, if a day load should be acquired, it would tend to overlap the maximum lighting load, which in winter time comes on before six o'clock, and on dark days may be an hour or two earlier. The result would be that the double load, which at most would last but two hours, and which in the summer time would not exist at all, would have to be provided for by machinery which would be idle the rest of the day. It is clear, therefore, that this change would not better matters much.

(To be continued.)

MOUNTAIN-CLIMBING RAILWAYS.

BY ERNEST SCOTT.

(Continued from page 430.)

In 1879 Messrs. Thos. Cook and Sons decided to build a cable railway up the rugged side of Mount Vesuvius, over which for centuries stumbling and swearing *lazaroni* had dragged travellers to the summit. The power station is at the bottom of the track. It contains the 45-h.p. engine and boilers for working the cable, and also a dynamo for running the arc lights at night. The peculiarity of the track is the single-rail construction, which consists of wooden stringers laid longitudinally and carrying a single rail, upon which ride the central wheels of the car. There are, however, two other rails placed on either side of the base. These side rails are adapted to wheels whose axes project from the floor of the coaches and bear closely against the rails on either side of the sleeper, thus keeping the carriage firmly upright. Although the railway is only just over half a mile long it cost £16,000, a large proportion of which was expended in transporting materials for the railway. The maximum gradient is 63 per cent., and the journey takes 10 minutes. Each car carries 11 persons. The cable is of steel, $\frac{7}{8}$in. diameter, with hempen core. There are six strands of eight wires each. There are two cars, and as one descends the other is drawn up the mountain. Should the weight of the descending car overbalance that of the car going up, the brakes with which the winding-drums in the power-house are equipped regulate the speed of the machinery.

The railway at Barmen, in Rhenish Westphalia, was one of the first to be operated by electricity. It is just over a mile in length, the average gradient being 1 in 10 and the most severe 1 in 5. The railway constitutes a double line throughout, and the gauge is 3ft. 3$\frac{3}{8}$in. The cars accommodate 36 persons, and each car is equipped with two electric motors of 36 h.p. The motors actuate gearing which drives pinions gearing into the rack rail laid in the centre of the line. The current is collected from a copper conductor, as in the usual overhead trolley system, and after operating the motors returns by the rails to the generating station in the town. The generating pressure is 560 volts, and the overhead conductor is carried on transverse span wires, fixed to iron pillars in the town and to wooden masts in the open ground. The cars are provided with three brakes, and, including the termini, there are four stations.

The Brienz-Rothhorn reaches the highest point of any of the European railways. It summit level is 7,388ft. above the sea, being 610ft. higher than the Mount Pilatus Railway. The steam locomotives were built at the Swiss Locomotive Company's works, and cost £1,680 each. They weigh when empty 13 tons, and carry ·7 ton of coal or briquettes, 1·2 tons of water in tank, 1·2 tons in boiler, ·9 ton for cooling purposes, and oil, tools, and sundries make up a total weight of 17 tons. This load is distributed over three pairs of axles. The carriages were supplied by the Swiss Industrial Company, of Neufhausen, for £320 each.

The Wengern Alp Railway connects Lauterbrunnen and Grindelwald; it is single track, with passing loops at the station and at a point midway between Wengern and Wengern Alp. It is one of the longest lines that has yet been built, being 11·18 miles long altogether (10·68 miles of Wengern Alp railway). The return fares for the whole distance are 12s. for second class and 7s. 6d. for third class. The rack rail (Riggenbach system) is of improved form. The channel bars are specially rolled, with the upper portion of the web thickened where the rungs, 3$\frac{1}{2}\frac{5}{8}$in. pitch, forming the rack pass through. The top of each channel is bent slightly outwards, and the rack, being 3$\frac{1}{2}\frac{5}{8}$in. in clear width, gives ample room for the lateral play of the rack wheels, 2$\frac{3}{8}$in. broad, in passing round curves, etc. There are two rack wheels, not one, so that the stress on the teeth is reduced to half, and the unavoidable gap of rack rail at points and crossings is rendered workable, one or other of the rack wheels being always engaged. Each rack wheel has 18 teeth, and the distance apart of these wheels is 4ft. 5$\frac{3}{16}$in.

The Territet Glion-Naye wire-rope railway is worked on the water-ballast system. There are two inclines. The lower one from the Lake of Geneva to the village of Glion, 1,000ft. above, was laid down in 1883; the upper one, forming the extension from Glion to Naye, being put down just 10 years later. The line is single track, with a turn-out about the centre. There is a rack midway between the rails, but it is for braking purposes only. The cable is 1$\frac{1}{4}$in. diameter and weighs 8·47lb. per yard. The car when empty weighs 8·66 tons, with tank filled, but without passengers it weighs 13·68 tons; as against 11·81 tons for the laden car with its tank empty.

The Mount Salève rack railway was one of the first to be worked with electricity. The track is laid on the well-known Abt system, 3ft. 3$\frac{3}{8}$in. gauge; but, instead of overhead wires, a conductor rail of the same section as the ordinary rail is used, and, as in several of the American lines, it is placed about 18in. outside the left-hand rail. It is inverted, and its base used as contact surface. At distances of 6ft., or at every alternate sleeper, the inverted head of the conductor is held by an iron clamp and cap, which rests on a double porcelain bell insulator, 3in. diameter, this being in turn supported by a bent iron bracket fastened to the surface of the transverse sleepers. There is a complete metallic return beside the rails. The generating station is situated at Arthaz, on the River Arve, which is really a mountain torrent descending from Mont Blanc and discharging into the Rhone just below the lower end of the Lake of Geneva. The financial results show that there is a great saving in using this water power. The dynamos are among the largest yet made, and are of the multipolar Thury type with 12 poles. They weigh 19 tons each, and are coupled direct

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to the vertical turbine shaft, which is 7⅞in. diameter. The outside diameter of the dynamo is 10ft. 6in., and the diameter of the armature 6ft. 9in. At a speed of 45 revolutions the effective output is 600 volts 275 amperes, or 165 kilowatts, equal to 220 e.h.p The commutator is 5ft. 9in. diameter, and current is taken off by 36 carbon brushes in 12 sets, which are fastened to ebonite holders and pressed by springs against the collector surface. There is practically no sparking, owing to the substitution of carbon blocks for the ordinary copper brush. The two motors with which each car is fitted are four-pole series-wound, and in series with each other. The armature is 16in. diameter by 32in. long. They develop 30 h.p. at 600 revolutions per minute. The rack pinions are driven through double gearing, the reduction being 12 to 1. The speed regulator is composed of a handwheel, which, by worm gearing, acts on a regulating switch having forward and reverse motion, two sets of contacts each connecting by as many conductors with the resistance coils made of iron wire, and carried under one of the platforms of the car. The total costs amounted to £92,000. The losses are 48 per cent., of which 10 per cent. are in the generators, 12 per cent. in the transmission and conducting rails, and 26 per cent in the motors and gear. Unlike most others, this line is intended to work all the year round when not prevented by snow or by the freezing of the turbines. In summer there are 30 up and down trips per day, and in winter 15. The maximum traffic would be 1,100 persons a day, and the fare from Geneva and back is 4s. 6d.

The most conspicuous recent advance in mountain climbing by mechanical means has been the building of cable railways up the Burgenstock, Monte Salvatore, and Stanserhorn. In each case the winding-drums are worked by electric motors. The Stanserhorn line was only opened in 1894, and all three lines have been financed and built by a large Swiss firm of contractors, Messrs. Bucher and Durrer. As far as is possible, the profile of these cable lines are a concave parabolic curve.

The Burgenstock line is single throughout, with an automatic turn-out midway up the incline. This crossing is Mr. Abt's design, and is exceedingly simple. In order to effect the crossing of the up and down cars the outer wheels of each car have a double flange, and as they always run on the outer rail do not come in contact with the rack. The car wheels on the other side are flat, and being without flange and extra wide, they cross easily and smoothly over the rack and joints of the rails. The cable is Lang's patent, of crucible cast steel with hemp core, its diameter being 1 18in. and its weight 6·4lb. per yard. The steel cable is divided into 114 wires arranged in six strands, and the breaking strength is 46 tons, this giving a factor of safety of about 9 The life of the cable, making a mileage of 2,000 miles per annum, may be taken at about 10 years. The cable is worked through gearing having a reduction of 140 to 1 by two Thury motors, 25 h.p. each. Current is derived from a hydro-electric power station near Buochs, 2½ miles distant, the transmission being on the three-wire system at 1,600 volts This station also supplies the Stans road and the Stanserhorn railways with electric power.

The Monte Salvatore Railway is almost exactly like the Burgenstock, the principal points of difference being that the line is built in two sections and is single track throughout ; a midway station (where passengers change) taking the place of the automatic turn-out on the Burgenstock line. The total weight of the permanent way is 172lb. per yard as against 192lb. per yard on the Burgenstock. The cable is composed of 90 wires arranged in six strands ; its diameter is 1·26in. and weight 6·8lb. per yard, and its tensile strength 54 tons giving a factor of safety of 10. The hydro-electric generating station is five miles distant, current being transmitted at 2,000 volts The return fare is 3s. 3d.

The Stanserhorn line being built without a rack, the total weight per yard comes out lower than the other lines, being only 134lb. per yard. The saving in material and labour is about £1. 4s. per yard. The speed of the car is regulated at the motor station, automatic and electric signals acquainting the driver of the position of the cars on the line. As mentioned above, current for the motors is generated at the central station at Buochs, and is supplied at the fixed charge of £4 per horse-power per annum. The power is transmitted at 1,600 volts through six conductors (two to each station) ·35in. diameter, the mean loss in volts being 12 per cent. The Stanserhorn Cable Railway is built in three sections, each worked with a separate cable and a midway automatic turn-out. The advantages of this are that the carrying capacity of the line is very much increased and the cable is not so unwieldy. The feature of this railway is that, instead of the usual rack, a special safety brake, acting on the rails (by clutching the rail-head), is used. This elimination of the rack gives a considerable saving in first cost of permanent way, more space for the cable and rollers, and greater simplicity in working. The rail clutch-brake, of which there are three to each car, acts both automatically and under control of the driver. Each consists of a pair of jaws, like a pair of pincers, which normally travel along the triangular-shaped rail-head with a clearance of about ¼in. When the car speed unduly increases, they close on the rail and arrest the car by friction pressure. Again, in the event of the cable snapping, two counterpoise weights of 110lb. each, which are usually held up by the tension of the cable, fall and act by levers on the gearing which operates the jaw brake. The total mileage of the cables used on these railways will probably be about 20,000 miles, and this with the present rate of traffic on the Stanserhorn Railway—viz., 10 trains per day for six months—gives a life of seven years. These three electrically-worked lines show a saving of 50 per cent. in cost of construction and working expenses when compared with the Lauterbrunnen and Pilatus Railways.

(To be continued.)

ABERDEEN CORPORATION ELECTRICITY WORKS.

The following are the particulars of the electric light accounts of the Corporation for the period from February 28, 1894, to December 31, 1894 :

Revenue and Expenditure Account.	£	s.	d.
Sale of current, per meter, at 7d. per Board of Trade unit	1,679	11	1
Public lighting	113	16	1
Rental of meters	56	13	2
	£1,850	0	4
Cr.	£	s.	d.
Fuel	189	1	1
Oil, waste, water, and engine-room stores	60	10	7
Wages at generating station	146	12	4
Repairs on buildings	1	11	7
Repairs on plant	2	12	7
Main and service repairs	13	13	10
Attending and maintaining public lamps to May 16, 1894	15	7	3
Feu duty and taxes	102	19	8
Management	50	0	0
Salaries of engineers	252	6	0
General establishment charges	21	19	5
Stationery and printing	9	16	3
Insurance	12	9	6
Inspector's wages	0	9	5
Balance carried to net revenue account	970	10	10
	£1,850	0	4

Net Revenue Account.	£	s.	d.
Balance brought from revenue and expenditure account	970	10	10
Balance chargeable against the gas department—carried to general balance account	217	15	6
	£1,188	6	4

Cr.	£	s.	d.
Interest on mortgage and other loans	523	5	6
Depreciation for 10 months on amount expended on capital account at February 28, 1894 :			
Buildings, £3,375 at 1 per cent. (£28 2 6)			
Machinery, £4,289 at 5 per cent. (178 14 2)			
Accumulators, £571 at 5 per cent. (23 15 10)			
Mains and services, £8,119 at 1½ per cent. (101 9 2)			
Electrical instruments, £1,150 at 2½ per cent. (23 19 2)			
Meters, 296 at 5 per cent. (12 6 8)	368	7	6
Sinking fund on £17,800, at 2 per cent., for 10 months	296	13	4
	£1,188	6	4

General Balance Account. Assets.	£	s.	d.
Capital account—amount expended for works	23,189	7	6
Sundry debtors for current supplied to December 31, 1894, outstanding	1,341	8	9
Stores on hand at December 31, 1894—coal, £11. 14s.; oils, waste, etc., £3. 10s. 1d.; engine spares, cable, etc., £417. 16s. 6d.	433	0	7
Cash in hand	4	3	10
Net revenue account—amount at debit thereof, chargeable against the gas department	217	15	6
	£25,185	16	2

Liabilities.	£	s.	d.
Capital account—Amount of mortgage loans	20,000	0	0
Amount of temporary loans	2,570	0	0
North of Scotland Bank	1,495	0	2
Amount due to sundry creditors	804	2	8
Amount of deposits in security for current	20	0	0
Sinking fund	296	13	4
	£25,185	16	2

THE ELECTRIC LIGHTING OF EDINBURGH.

The inauguration of the public installation of electric light in Edinburgh took place on Thursday last week. The Edinburgh Corporation electric light order was passed in 1891, but it was not until April 21, 1893, that the Town Council, by resolution, resolved to keep the electric lighting in its own hands. An electric light sub-committee was elected with Mr. A. D. Mackenzie as convener ; Prof. Kennedy was appointed consulting engineer to the Corporation, and Mr. Monkhouse resident engineer. The first installation resolved on was one of considerable magnitude — estimated, as it was, to cost about £85,000, independently of site and station buildings—and the carrying of it into effect has represented during the past 18 months an immense amount of anxious and arduous work to all concerned. The scheme has been

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enlarged considerably since its inception, and may probably be set down to cost something like £120,000.

The central electric light station is situated in Torphichen-street and Dewar-place, in close proximity to the Caledonian Railway, with which it will be connected by a siding for the direct delivery of coal and other material. Designed, says the *Scotsman*, by Mr. Cooper, burgh engineer, in the Italian Renaissance style, it is a solidly built structure of red freestone, with certain ornamental features, chiefly associated with its fenestration. The engine-house, which is 104ft. by 90ft., is divided into two large naves, separated from each other by a series of cast-iron columns. The boiler-house is a long, oblong building alongside the engine-house, 150ft. by 46ft. One half of the engine-house is set apart for the low-tension distribution dynamos, and it is these which are now being utilised. In the other half will be placed the engines and dynamos for the high-tension distribution, but these are not yet in position. The engines and dynamos are in two parallel rows on each side of a broad gangway along the centre of the engine-room, and together represent nearly one-half of the low-tension plant of 1,500 i.h.p. The engines are of the horizontal compound type, and run at a speed of from 350 to 400 revolutions per minute. They drive the dynamo direct. There are eight dynamos in all. Two are balancing machines of 100 h.p. each, which will be used for equalising the load on the two sides of the three-wire system; two are charging machines of 100 h.p. each for charging batteries and other purposes; two are of 250 h.p.; and the two largest are of 360 h.p.

The space beyond the engine platform is left for extension. It is at present 3ft. lower than the platform, but that is merely for convenience of working. In the high-tension side there will be fitted up within the next few weeks two engines of 150 h.p., each driving an alternator. They will be used at first for long-distance arc lighting in such streets as the Canongate and Clerk-street, and later when required for providing current to other districts considerably removed from the central station.

At the west end of the engine-house, at an elevation of 4ft. above the general floor, there is the switchboard platform. In each of the two sections of the engine-house are overhead travelling cranes, which have been of great use in lifting machinery and other plant. The walls are lined up to a height of 12ft. with white glazed bricks, and at that height is a narrow cornice of green glazed tiles. The pipe for the steam supply is hung from brackets round the walls in the form of a ring with two openings into the boiler-room. It is divided into a series of sections with stop-valves, so that with the two boiler-house openings it virtually gives a duplicate steam supply in case of accidents. The main exhaust-pipe for the waste steam is carried in a tunnel under the flooring, and discharges itself into the main chimney stalk, but before doing so it is utilised to heat the feed-water before it goes into the boilers. The main chimney stack is 165ft. in height from the ground line, and is of rather ornamental design. It is octagonal in plan, and has pilasters and panels, with moulded cornice and cap.

The boiler-house, the east end of which is not yet finished, contains six large double-furnace boilers, of marine type, fitted with Sinclair's mechanical stoking arrangement. The boilers, which were made by Mr. George Sinclair, of Leith, are to work up to a pressure of 160lb. to the square inch, and they have been tested and have proved themselves thoroughly sound and tight up to a pressure of 320lb. The system of superheating the steam after it leaves the boilers by means of the waste gases from the furnaces has been adopted, and is likely to give good results both from an engineering and an economical point of view. In the centre of the boiler-house is Berryman's feed-heating apparatus. On the other side there are feed-pumps driven by electricity, to take the place of the ordinary donkey pumps for feeding the boilers with water. This, it is believed, is the first time that such pumps have been put up in a British station. There is also an electrical motor for driving the mechanical stokers. Over the boiler-house will be a large second floor, carried on iron beams, which will be used as a coal-store, from which there will be "tips" into the mechanical stokers. Over one part of the engine-house is a battery-room, where are placed large nests of secondary batteries, which will be used for giving off current during the day, either for lighting or motive power, when the machinery is not running. There are batteries here sufficient to keep going 1,200 lamps of 8 c.p. for five hours. These batteries will allow the station to be shut down in summer at 4 a.m. or earlier, and kept shut down until four or five the next afternoon, or even later; and they are regarded as of great importance in the economy as well as in the convenience of management of the station. The regulation of these batteries and the placing of them in circuit is carried out by an ingenious arrangement devised by Mr. Jenkin (a son of the late Prof. Fleeming Jenkin), one of Prof. Kennedy's assistants. On the same level are rooms for the testing and storing of electrical meters—of which two kinds are to be used—the Kelvin and the Ferranti—and rooms for general stores, with a lift to St. Cuthbert's-lane. The main staircase is placed in an annexe to the west of the chief building in Dewar-place, and in the same building are the offices of the staff. Opening from one of the landings of the staircase is a spectators' gallery, built out of the wall at a corner of the high-tension side of the engine-house, from which all the machinery may be overlooked.

The distributing system adopted is a low-tension continuous-current three-wire one, with batteries for all the central and western part of the city—in fact, for all the part in which distributing mains are laid. This low-tension distribution will be extended as time goes on to all the closely-populated parts of the city. Meantime, outlying districts and residential suburbs, where houses stand far apart in gardens and isolated from each other—where the cost of mains for consumer is a maximum, and where the receipts per lamp per annum are a minimum—are to be supplied by alternating current, leaving the station at high pressure (2,000 volts), and transformed down by isolated transformers to 100 volts or 115 volts for the consumer.

Princes-street is lighted with a series of arc lamps hung on ornamental brackets 23ft. in height, and placed about 50 yards apart on the north side of the street. Each of these is of 15-ampere power, which popularly is set down as representing 3,000 candles, so that when the light is turned on Princes-street will be one of the best lighted streets in Europe. The total number of arc lamps which will be used for street-lighting purposes is 175. The lamps are of the Crompton-Pochin type.

The whole scheming of the work, the choice of system, the arrangement of station, the sizes and arrangement of plant, the plan of mains, etc., the whole preparation of the detailed specifications, and the general supervision of the execution of the scheme, have been performed by Prof. Kennedy, acting as consulting engineer to the Corporation.

The principal contractors were: Buildings (amount £18,297), W. Turner and Sons, Morrison-street, Edinburgh; boilers and superheaters, George Sinclair, Leith; machinery generally, Siemens Bros., Woolwich; with sub-contractors (*a*) for engines, Willans and Robinson, Thames Ditton; (*b*) for pipes, etc., Alley and Maclellan, Glasgow; switchboard and instruments, Siemens Bros.; batteries, the Crompton-Howell Company; cables, Henley's Telegraph Works, Siemens Bros., and the India Rubber Company, Silvertown; stoneware casings for road-work, Doulton; arc lamps, Crompton and Co.; arc lamp-posts, Mackenzie Bros., Edinburgh; iron-work generally, Shaw and Co., Glasgow, and R. Maclaren and Co., Glasgow; alternators, Ferranti and Co.; with engines by Willans and Robinson; rectifiers for the arc lamps on the alternating-current circuit, Ferranti and Co.; high-tension switchboard, Ferranti and Co.

COMPANIES' REPORTS.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Sir John Pender, G.C.M.G., M.P., chairman; Admiral of the Fleet Lord John Hay, G.C.B.; Admiral Sir George H. Richards, K.C.B., F.R.S.; Sir Eyre M. Shaw, K.C.B.; J. C. Parkinson, Esq.; J. Denison Pender, Esq.; John B. Verity, Esq. Secretary: E. Cunliffe Owen, Esq., C.M.G. Chief engineer: Frank Bailey, Esq., A.M.I.C.E. Acting engineer: A. H. Walton, Esq., A.M.I.C.E. Consulting engineers: Lord Kelvin, D.C.L., Pres.R.S.; Dr. John Hopkinson, F.R.S.

Report of directors and abstract of accounts to be presented to the shareholders at the eighth ordinary general meeting of the Company to be held at Winchester House, Old Broad-street, on Wednesday, April 24, at 12 noon.

The capital expenditure, which at the end of 1893 amounted to £585,932. 8s. 9d., now shows a total of £628,931. 7s. 1d., being an increase during the year of £42,998. 18s. 4d. This increase is mainly accounted for by the growth of the Company's business, necessitating an increase of plant as well as the continual extension of mains, and the additional provision of transformers, meters, and other appliances. Litigation has taken place in connection with the works at South-street, Manchester-square, arising from complaints that vibration was caused to the neighbouring houses. The measures which the directors have taken to remove all cause for such complaints have now been successfully carried out. Considerable difficulty was experienced in maintaining the public supply while the alterations were in progress, and a material increase in working expenditure throughout the Company's entire system was thereby incurred. The gross revenue for the year amounted to £85,345. 18s. 7d., against £69,195. 4s. 4d. in 1893, being an increase of £16,150. 14s. 3d., as compared with the increase of £14,623. 5s. 4d. in 1893. It will be seen that the growth of the income has steadily kept pace with that of the lamp connection, notwithstanding that the directors have found it necessary to introduce a sliding scale of charges in favour of large consumers of current. The balance to the credit of the revenue account before providing for depreciation is £29,998. 2s 4d. The directors have set aside £8,000 as an addition to the depreciation fund, carrying to the credit of the net revenue account the sum of £21,998. 2s. 4d., which, with the balance brought forward from the last account and other receipts, makes a total of £23,761. 12s. 4d. After deducting debenture interest and other charges, there remains a balance of £16,909. 2s., of which the directors have appropriated a

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further sum of £1,000 in reduction of the preliminary expenses account, which is now diminished to £2,052. 10s. 4d. The directors recommend that a dividend of 6s. per share on the ordinary share capital be now paid, which will absorb a sum of £14,970, and leave a balance of £939. 2s. to be carried forward to the next account. In view of the increased capital expenditure consequent on the extension of the Company's business, and to take advantage of the favourable condition of the money market, the directors decided to replace the 5 per cent. debenture bonds by the creation of £250,000 4½ per cent. first mortgage debenture stock, of which a portion, amounting to £150,000, was issued in July. With the funds thus obtained, the whole of the £100,000 5 per cent. bonds have been redeemed, and a further sum of £50,000 provided for current capital expenditure. The net premium derived from the issue has been carried to the credit of the depreciation fund. The number of 8-c.p. lamps supplied by the Company increased during the year 1893 from 166 000 to 209,000. The present number of lamps connected is 224,000, and the applications show no signs of decrease. A report from the Company's chief engineer is appended, showing that the satisfactory condition of the stations, machinery, and plant has been maintained. In accordance with the articles of association the following directors—viz., Admiral Sir George H Richards, K.C.B., F.R.S., Sir Eyre Massey Shaw, K.C.B., and John B. Verity, Esq.—retire from the Board, and, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and offer themselves for re-election.

REVENUE ACCOUNT FOR YEAR ENDING DEC. 31, 1894.

A.—To Generation of Electricity.

Dr.	£ s. d.	£ s. d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	23,219 4 5	
Oil, waste, water, and engine-room stores	3,787 15 5	
Salaries of engineers, superintendents, and officers	2,085 13 4	
Wages and allowances at generating stations	6,544 11 6	
Repairs and maintenance, as follows: buildings, £371. 4s. 7d.; engines, boilers, £4,386. 12s. 11d.; dynamos and exciters, transformers, motors, etc., £1,024. 14s. 2d.; other machinery, instruments, and tools, £902. 11s. 1d.; accumulators and accessories, £43. 2s. 7d.	6,728 5 4	
		42,365 10 0
B.—To Distribution of Electricity.		
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	140 17 0	
Repairs, maintenance, and renewals of transformers, meters, and other apparatus on consumers' premises	348 9 4	
Royalties	12 15 0	
		502 1 4
C.—To rents, rates, and taxes		3,653 15 3
D.—To Management Expenses.		
Directors' remuneration	2,175 0 0	
Salaries of management, secretary, engineers, accountants, clerks, and messengers	3,499 7 7	
Wages of meter readers and wiring inspectors	349 11 3	
Stationery and printing	542 10 3	
General establishment charges	1,569 1 11	
Auditors—Board of Trade, £86; Company's auditors, £157. 10s.	243 10 0	
		8,379 1 0
E.—To Law and Parliamentary Charges.		
Law expenses		127 5 2
F.—To Special Charges.		
Insurances		320 3 6
G.—To Depreciation Fund.		
Depreciation in buildings Depreciation in plant, machinery, etc.		8,000 0 0
Total expenditure		63,347 16 3
Balance carried to net revenue		21,998 2 4
		£85,345 18 7

Cr.	£ s. d.
Sale of current	79,667 9 2
Less bad and doubtful debts	600 0 0
	79,067 9 2
Rental of meters and other apparatus on consumers' premises	5,922 7 7
Rents receivable	101 0 0
Special items—net proceeds of work done for and goods supplied to sundry consumers	108 12 8
Surplus properties—rents and profits after deducting cost of repairs, rents, rates, taxes, and expenses of management	146 9 2
	£85,345 18 7

Dr. NET REVENUE ACCOUNT, DEC. 31, 1894.	£ s. d.
Bank charges and commission	6 13 8
Interest due and accrued on debentures	5,645 16 8
Suspense accounts waiting adjustment	1,200 0 0
Amount written off on account of preliminary expenses	1,000 0 0
Balance applicable to dividend on ordinary stock or shares	15,909 2 0
	£23,761 12 4

Cr.	£ s. d.
Balance brought from last account	13,548 19 4
Less dividend of 5s. per share paid May 1, 1894	12,475 0 0
	1,073 19 4
Balance brought from revenue account	21,998 2 4
Discounts	578 10 0
Interest account	30 9 8
Transfer fees	80 11 0
	£23,761 12 4

Dr. GENERAL BALANCE-SHEET, DEC 31, 1894.	£ s. d.
Capital account—amount received	650,000 0 0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	16,978 10 6
Sundry creditors on open accounts	3,668 4 7
Depreciation fund	18,930 16 9
Net revenue account—balance at credit thereof	15,909 2 0
	£705,486 13 10

Cr.	£ s. d.
Capital account—amount expended for works	628,931 7 1
Stores on hand—coal, £562. 10s.; oils, waste, etc., £448. 18s. 6d.; general, £6,852. 19s. 9d.	7,864 8 3
Sundry debtors for amounts paid on account of contracts in course of completion	2,529 0 9
Preliminary expenses, £3,052. 10s. 4d.; less charged to net revenue account, £1,000	2,052 10 4
Sundry debtors for current supplied	32,483 15 4
Other debtors	824 12 5
Deposits (provisional orders, vestries, etc.)	1,080 0 0
Depreciation fund, investment account	11,000 0 0
Cash at bankers—on deposit account, £14,004. 17s. 6d.; on current account: Messrs. Prescott, Dimsdale, and Co., £1,444 5s. 10d.; the Royal Bank of Scotland, £3,271. 16s. 4d.	18,720 19 8
	£705,486 13 10

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Right Hon. D. R. Plunket, Q.C., M.P., chairman; J. B. Braithwaite, jun., deputy-chairman; W. C. Braithwaite; Anthony N. Denny; Frederick W. Reynolds; Aymor H. Sanderson; Francis E. Savory; R. Percy Sellon; B. H. Van Tromp. Engineer and manager: A. J. Lawson, M.I.E.E.

Directors' report and balance-sheet to December 31, 1894, to be presented to the annual general meeting of the Company, to be held at the City Terminus Hotel, Cannon-street, E.C., on Monday, April 22, 1895, at 2 p.m.

Since the balance-sheet was made up the first issue of 10,000 preference shares of £10 each has taken place, and the amount offered was very largely over-subscribed. An application for the quotation of both the ordinary and preference shares in the Stock Exchange official list has been made. The accounts show a considerable capital expenditure within this, the first year of the Company's operations upon works now in progress. On the profit and loss account for the year, after payment of usual general charges and writing off preliminary expenses on account of the Canterbury Electricity Supply Company's undertaking, which amounted to £308. 12s. 2d., a credit balance of £332. 5s. 10d. remains. The laying of pipes for mains and construction of drawing-in boxes within the St. Luke's and Clerkenwell districts is approaching completion. Cables are being delivered and laid, and it is hoped that by the end of September next both the St. Luke's and Clerkenwell districts will be supplied with current from the generating station which is now being built at City-road basin of the Regent's Canal. Street works in the Wandsworth district have been unavoidably delayed, but upon settlement of the regulations by the Board of Trade, main-laying can be forthwith commenced. The plans of the generating station buildings are nearly completed. An application for a provisional order for the district of St. Olave, Southwark, has been made to the Board of Trade, and the consent of the local authority to that application has been obtained. This district adjoins that of St. George-the-Martyr, Southwark (for which the Company now holds a provisional order), and both areas can be supplied from one generating station. The Bournemouth station, in which the Company holds the controlling interest, has within the past year made material progress. The number of consumers has considerably increased, so that at the end of the year there were connected an equivalent of 19,000 8-c.p. lamps, or 4,500 in excess of the number supplied at the end of 1893. To meet with the steadily increasing demand a further capital expenditure has been necessary for extension of station buildings and for additional plant and mains. Upon the completion of the work in progress the Bournemouth station will have a capacity of 27,000 8-c.p. lamps con-

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nected, with a total capital expenditure not exceeding £75,000. The Company is also the principal shareholder in the Dover Electricity Supply Company, of which Sir William Crundall, mayor of Dover, is chairman. The station of that company is now completed, part of the plant has been erected, current is being supplied, and the remainder of the machinery under the original contract will shortly be delivered. Contracts for public and private lighting are already entered into for the equipment of 2,200 8-c.p. lamps, and other contracts are in course of negotiation. A provisional order has been applied for in the name of the Windermere and District Electricity Supply Company for the supply of electricity for lighting, power, and other purposes in the towns of Ulverston, Grange, Cartmel, Bowness, Windermere, Rydal, and Grassmere, and in all these cases the consents of the local authorities to the application of the Company have been obtained. A controlling interest in the company holding the provisional order for Richmond (Surrey), with a central station well equipped and in active work, has recently been acquired on reasonable terms. The retiring directors are the Right Hon. D. R. Plunket and Mr. F. W. Reynolds, who are eligible for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re election.

BALANCE-SHEET, DEC. 31, 1894.

	£	s	d
Capital authorised	800,000	0	0
Capital issued £200,000 0 0			
Less March call not due 40,000 0 0	160,000	0	0
Calls paid in advance	1,228	0	0
	161,228	0	0
Less calls unpaid October 400 0 0			
,, ,, December 25,722 0 0	26,122	0	0
	135,106	0	0
Less capital applied to North London order 16,479 4 1			
Capital applied to Wandsworth order 7,638 8 11	24,117	13	0
	110,988	7	0
Sundry creditors	8,935	15	9
Balance from profit and loss account	332	5	10
	£120,256	8	7

	£	s	d
Lands and buildings, etc.	6,670	6	0
Preliminary expenses (suspense account)	13,688	7	6
Shares in associated electricity supply companies at cost—			
Bournemouth and District Electric Supply Company, Limited... £26,555 0 0			
Dover Electricity Supply Company, Limited 20,000 0 0	46,555	0	0
Advances to Associated Electricity Supply Companies, Limited—on mortgage 7,000 0 0			
On bills of exchange with £5,000 collateral security, £8,638. 9s. 5d.; less rebate of interest unaccrued, £137. 5s. 8,501 4 5	15,501	4	5
Head office furniture, books, etc.	510	3	7
Sundry debtors	12,276	12	5
Cash at bank and in hand	25,054	14	8
	£120,256	8	7

PROFIT AND LOSS ACCOUNT, DEC. 31, 1894.

	£	s	d
Salaries	539	8	0
Legal charges	83	18	5
Rent	210	8	0
Sundry charges	14	11	0
Office expenses	115	11	3
Printing and stationery	256	4	10
Postages and telegrams	31	7	7
Travelling expenses	131	14	4
Drawing office expenses	33	5	1
Depreciation account	23	19	8
	1,440	8	2
Canterbury Electricity Supply Company, Limited—expenditure in connection with transfer of provisional order written off	308	12	2
Balance carried to balance-sheet	332	5	10
	£2,081	6	2

	£	s	d
Payments from associated companies on management account	437	4	0
Transfer fees account	4	0	0
Interest account, £1,777. 7s. 2d.; less interest unaccrued, £137. 5s.	1,640	2	2
	£2,081	6	2

OXFORD ELECTRIC COMPANY, LIMITED.

Directors: Sir Henry C. Mance, C.I.E., M.I.C.E. (chairman); Jas. W. Barclay; Robert Buckell, J.P.; L. A. Selby-Bigge, M.A.; John Irving Courtenay, M.A. Engineer: J. Hardie McLean, M.I.E.E. Secretary: Hy. Eeles.

Report of the directors and abstract of accounts for the year ending December 31, 1894.

The revenue account shows a gross profit of £1,701. 17s. 2d. After providing for the full interest of 5 per cent. on the debenture issue and other interest, there remains £456 2s. 10d., which, added to the amount brought forward from the previous year, £68. 8s. 5d., leaves an available balance of £524 11s. 3d. The directors recommend that a dividend of 1 per cent., free of income tax, be paid upon the ordinary shares, which will absorb £329. 6s. 7d., leaving £195 4s. 8d. to be carried forward to the next account. The running of the plant during the year has given entire satisfaction. The supply of current to the public has been uninterrupted day or night from the time the Company commenced operations. Since the last report 4,194 8-c.p. lamps (or their equivalent) have been added to the system. On December 31 the number of lamps connected equalled 11,206 8-c.p. lamps. Thirteen colleges are now connected to the mains, and the directors have every reason to hope that the increase in the number of lights during 1895 will be equally satisfactory. During 1894 extensions have been made to Beaumont and Worcester streets, Magdalen Schools, St. Aldate's, St. Giles's, and the north of Oxford (Banbury-road, Norham-gardens, Norham-road, Bardwell-road, North-parade-avenue). These extensions involve considerable capital expenditure, for which provision has been made. The results so far have been sufficiently encouraging to justify the expectation that there will be a substantial addition to the number of consumers in the north of Oxford during the present year. The plant has been maintained in efficient order, and the expenditure of coal per unit of current generated reduced to ·44 of a penny. The directors who retire by rotation are Sir Henry Mance and Mr. James W. Barclay, who offer themselves for re-election. Mr. W. S. Carver, the auditor, retires, but offers himself for re-election.

REVENUE ACCOUNT, DEC. 31, 1894.

Generation of Electricity—	£	s.	d.
Coal and expenses for placing same upon works	428	0	3
Oil, waste, water, and engine-room stores	29	15	5
Wages at generating station	401	2	6
Proportion of managing engineer's salary	50	0	0
Maintenance charges — Buildings, £37. 3s. 8d.; engines and boilers, £180. 17s. 9d.; dynamos and transformers, £73. 4s. 5d.; machinery and tools, £27. 17s. 7d.; meters and switches, £10. 10s. 10d.; accumulators, £48. 0s. 2d.; works installation, £3. 11s. 6d.	381	5	11
Distribution of electricity—Proportion of managing engineer's salary, £50; wages at distributing station, £99. 17s. 6d.; maintenance of mains, £2. 11s. 1d.	152	8	7
Rent, £95. 2s. 6d.; rates and taxes, £156. 4s. 5d.	251	6	11
Management expenses—Directors' fees, £243. 10s.; salaries, £328. 5s.; insurance, £48. 2s. 6d.; legal expenses, £31. 19s.; audit fees, £21; printing and stationery, £67. 3s. 1d.; general establishment charges, £99. 13s. 9d.; carriage, £13. 8s 8d.	853	12	0
Cost of installations, services, sundry supplies, and charging launches	178	6	4
Balance, being gross profit carried to net revenue account	1,701	17	2
	£4,427	15	1

	£	s.	d.
Sales by meter	4,048	2	1
Less discounts and allowances	318	6	6
	3,729	15	7
Public lighting (less cost of carboning)	230	1	9
Rentals of meters and switches	101	19	8
Pupils' and other fees	86	7	0
Installations, services, sundry supplies, and charging launches	257	11	1
Rents receivable	22	0	0
	£4,427	15	1

NET REVENUE ACCOUNT, DEC. 31, 1894.

	£	s.	d.
Debenture and other interest	1,245	14	4
Balance	524	11	3
	£1,770	5	7

	£	s.	d.
Balance from last account	68	8	5
Revenue account	1,701	17	2
	£1,770	5	7

GENERAL BALANCE-SHEET, DEC. 31, 1894.

Dr.	£	s.	d.
Capital account as received	60,937	7	0
Sundry creditors on open accounts	2,261	5	5
Sundry creditors for debenture interest	557	4	8
Bills payable	2,716	3	4
Balance of net revenue account brought down	524	11	3
	£66,996	11	8

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Cr.	£	s.	d.
Capital account as expended	62,537	18	9
Sundry debtors	2,411	1	2
Cash at bankers	608	6	9
Cash in hand	1	9	7
Stock, coal, and other stores on hand	1,437	15	5
	£66,996	11	8

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD COMPANY.

Directors: Edward Overall Bleackley (chairman), 14, Chichester-terrace, Brighton; John Jackson Clark, Goldstone House, Hove; Richard John Pope, Beresford Manor, Plumpton; Magnus Volk, 36, Eaton-place, Brighton.

Report of directors, with abstract of accounts, for period ending December 31, 1894.

The directors regret that they are not able to announce the completion of the line, but owing to the delays that took place in making the necessary arrangements with the Board of Trade and the Corporation of Brighton the work of constructing the permanent way was not commenced in earnest till the end of July. Thus the best part of the year was lost, and the weather all through the autumn was so stormy, and the winter so intensely cold, that not only was progress necessarily slow, but the cost of the work was thereby considerably increased. During the last few weeks, however, rapid progress has been made, and if the weather continues favourable the directors expect to see the permanent way completed in the early part of the summer. Notwithstanding the heavy gales and the exceptionally rough seas to which it has been subjected, it is highly satisfactory to note that not the slightest damage has been done to any portion of the permanent way. The stability of the work may therefore be considered as perfectly assured, and the directors confidently anticipate that the undertaking will prove a very great success. As the railway may be fairly expected to greatly increase the popularity of Rottingdean as a summer resort, it has been considered desirable to erect the landing-jetty there on an enlarged scale, so as form a commodious pier, from which a good revenue may be reasonably anticipated. Arrangements have been made by which the Company will pay half the cost of constructing a sea-wall and promenade approach to this pier, which will improve the property of the Company and the appearance of the frontage at Rottingdean. It was originally intended to place the Brighton station on the beach on the west side of the Paston-place groyne; but it has been considered desirable to erect a jetty immediately to the east of the groyne, with a station thereon, so that passengers may reach the car with greater comfort. These works, as well as the Rottingdean pier, are practically completed. As the Corporation of Brighton raised objections to the generating machinery being placed in the Company's station, it became necessary to excavate an arch for this purpose in the concrete sea-wall close by, the site being granted by the Corporation at a nominal rent for 21 years, so as to recoup the Company the cost of constructing the arch. The original estimates did not provide for any of the additional works above mentioned. Moreover, the cost of laying the permanent way has been increased through being carried out in such unfortunate weather, and there have been other expenses, of which, in a work of so unique a character, it was difficult to form an accurate estimate. It will therefore be necessary to issue the balance of the share capital, amounting to £5,680, in order to complete and thoroughly equip the line. Of this sum the directors will subscribe £2,000, and the balance is offered in the first place to the existing shareholders Any portion not taken by them will be offered to the public. One director, Mr. Magnus Volk, retires by rotation, and, being eligible, offers himself for re-election. The retiring auditor is Mr. James T. Haslam, who offers himself for re-election.

RECEIPTS AND EXPENDITURE ON CAPITAL ACCOUNT, DEC. 31, 1894.

Expenditure.	£	s.	d.
Costs of obtaining Act of Parliament, and other preliminary expenses	2,320	0	0
Permanent way, jetties, buildings, plant, etc.	6,938	16	11
Wages	2,897	1	0
Engineering fees	301	16	0
Compensations	205	0	0
Secretary's salary	70	16	8
Accountant's fee	5	5	0
Town clerk's charges	7	0	2
Stationery, printing, account-books, certificates, seal, postages, etc.	94	16	6
Rents, rates, and taxes	43	17	7
Registration fee	20	0	0
Accidental insurance	37	10	0
Travelling expenses	34	11	1
Railway charges	23	1	7
Book-keeper's salary	11	0	0
Interest on loan	23	1	6
Sundries	20	18	5
Directors' fees	283	6	8
	£13,337	19	1

Receipts.	£	s.	d.
Discounts	82	19	2
Returns and allowances	138	16	11
Transfer fees	0	5	0
Balance carried to balance-sheet	13,115	18	0
	£13,337	19	1

BALANCE-SHEET.	£	s.	d.
Authorised capital—2,000 shares at £10 each	20,000	0	0
Loans	5,000	0	0
	25,000	0	0
Liabilities.			
Capital account—232 shares issued as fully paid	2,320	0	0
1,066 shares £10 each, £10,660; less calls in arrear, £1,703	8,957	0	0
	11,277	0	0
Loan and interest	1,023	1	6
Parliamentary deposit—advance	414	0	0
Creditors	1,400	4	7
	£14,114	6	1
Assets.			
Cash at bankers	527	10	10
Cash in hand	50	9	5
	578	0	3
Parliamentary deposit	414	0	0
Safe	5	10	0
Debtors	0	17	10
Balance from expenditure account	13,115	18	0
	£14,114	6	1

INDO-EUROPEAN TELEGRAPH COMPANY, LIMITED.

The report of this Company for 1894 states that the revenue from all sources amounted to £119,118, as compared with £122,860 for 1893, showing a decrease of £3,742. The expenses were—on commercial and general account, £32,841; on maintenance account, £31,998; total, £64,839, as against £64,960, a decrease of £121. Deducting the expenses, taking credit for £6,452 brought over, and debiting income tax, there remains £58,289. From this amount £10,000 has been placed to reserve, and that sum, together with £10,625 for interim dividend, have to be deducted, leaving a balance of £37,664 The directors now propose the declaration of a dividend for the last six months of 17s. 6d. per share, making, with the dividend already paid, 6 per cent. and a bonus of 20s. per share, both free of income tax, in all 10 per cent. for the year, carrying forward £5,789. It has been determined by the governments and companies interested, under slight modifications of the guarantee arrangements, owing to which the existing low tariff with Australasia was originally established, to continue its application for a further period of five years.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Llandrindod Wells.—The Urban District Council invite offers for the provisional electric lighting order for which they are applying.

South Shields.—Tenders are invited for the supply and erection of a 10-ton hand-power overhead travelling crane at the Corporation electricity works. We have already given particulars. Tenders to be delivered by 22nd inst.

Manchester.—The Lancashire and Yorkshire Railway Company require by the 30th April tenders for the supply of an oil-engine engine packing, signal and telegraph fittings, signal, telegraph and electric light wires, wire, etc.

Londonderry.—The Corporation invite tenders for the supply of carbons for one year from June 1, 1895. Schedules of quantities and further particulars may be obtained on application to Mr. John Christie, electrical engineer, Strand, Londonderry. Tenders, accompanied with samples, marked "Tender for Carbons," to be lodged with Mr. R. Chambers, town clerk, not later than May 1.

Huddersfield.—The Electric Lighting Committee of the Town Council invite tenders for 2in. and 3in. cast-iron spigot and socket pipes. Specifications and form of tender may be obtained on application from Mr. A B. Mountain, borough electrical engineer, St. Andrew's-road, Huddersfield. Tenders are to be delivered by the 26th inst. at the borough electrical engineer's office, marked "Tender for Cast-Iron Conduits."

Rangoon.—Tenders will be received by the president of the Rangoon Municipal Committee, not later than November 4, for the lighting of Rangoon by electricity. Tenders should be accompanied by detailed plans, specifications, and estimates, and must state the terms on which the installation proposed will be undertaken. All information regarding the existing system of lighting and the cost, etc., with plan of the town, can be obtained on application to Messrs. Ogilvy, Gillanders, and Co., Sun-court, 67, Cornhill, London, E.C., accompanied by a remittance of £1. 1s. Tenders are to be sent in sealed covers and endorsed "Tender for Electric Lighting, Rangoon." Mr. J. Short, Rangoon, is the secretary of the committee.

Brighton.—The Town Council invite tenders for the extension of the Corporation electricity generating station, North-road, comprising engine-room, boiler-house, coal stores, chimney shaft, and other works in connection therewith, for the Town Council. Drawings may be seen at the office of the borough engineer and surveyor, Mr. Francis J. C. May, M I.C.E., Town Hall, Brighton, where specification, bills of quantities, and forms of tender can be obtained after 10th inst. upon the payment of £5. 5s., which sum

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will be returned on the receipt of a *bonâ fide* tender. Sealed tenders, addressed to Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton, and endorsed "Tender for Extension of Corporation Electricity Station," must be left at the town clerk's office before 10 a.m. on 25th inst.

Birkenhead.—The Corporation invite tenders for the erection and completion of a brick chimney 124ft. high above concrete bed, and for the construction of the necessary foundations thereof, in connection with the electric light station. Plans, specifications, and particulars, with form of contract, can be seen, and (upon deposit of the sum of £1. 1s., which will be repaid upon receipt by the Corporation of a *bonâ fide* tender) bills of quantities, with form of tender, can be obtained, on application at the town clerk's office, Town Hall, Birkenhead, or at the office of Mr. James N. Shoolbred, M.I.C.E., Albany-buildings, 47, Victoria-street, London, S.W. Tenders, which must be on the prescribed form, sealed and endorsed "Tender for Erection of Chimney," must reach Mr. Alfred Gill, town clerk, Town Hall, Birkenhead, by 12 noon on 22nd inst.

RESULTS OF TENDERS.

Edmonton.—The District Council have accepted the tender of the Consolidated Telephone Construction and Maintenance Company, Limited, for street fire-alarms.

Hull.—The Electric Lighting Committee of the Town Council have accepted the tenders of Messrs. Willans and Robinson for an engine at £1,295 and Messrs. J. H. Holmes and Co. for a dynamo at £700.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—The receipts for the past week were £2,684.

The New Public Record Office.—This building in Chancery-lane is to be lighted throughout by electricity.

Glasgow.—The Theatre Royal is to be rebuilt at a cost of about £20,000, and the electric light is to be installed throughout. Mr. C. J. Phipps is the architect.

Basingstoke.—The Public Lighting Committee of the Urban District Council have decided that it is inexpedient at present to adopt a scheme of electric lighting.

Metropolitan Electric Supply Company, Limited.—Notice is given that the transfer registers of the Company will be closed from 18th to 25th inst., both days inclusive.

Argentina.—From Buenos Ayres, under the date of March 25, it is announced that the La Plata Telegraph Department is calling for tenders for supply of telegraphic materials.

Coventry.—The Town Council have ordered the corporate seal to be affixed to mortgages of the general district fund for raising £2,000 at 3½ per cent., for electric lighting, etc.

West India and Panama Telegraph Company.—For the half-month ended April 15 the receipts show a decrease of £214 as compared with the corresponding period of 1894.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 14th inst. amounted to £1,243, as compared with £655 in the corresponding week of last year.

British and Foreign Patent Syndicate, Limited.—This Company has been registered with a capital of £10,000 to carry on business as patent agents, to render assistance to inventors, etc.

Pure Carbon Company, Limited.—This Company has been registered, with a capital of £12,000, to adopt an agreement for the acquisition of certain patents, and to develop and turn to account the same.

Oriental Telephone and Electric Company.—A dividend at the rate of 4½ per cent. per annum is recommended by the Board for the period from the date of reconstruction—viz., March 12, 1894—to December 31 last.

Portsmouth.—The report of the Electric Lighting Committee with reference to the proposed extension of electric mains, at an estimated cost of £21,000, has been laid before the Council and adopted without discussion.

Coseley.—The Urban District Council have, on the motion of Councillor Wones, unanimously decided that the surveyor should prepare estimates showing the cost of lighting by electricity and other methods as early as possible.

Maidstone.—A meeting has been held of the Urban District Council at which Alderman Ellis said there was no report from the Electric Lighting Committe, who hoped, however, to make a report at the next meeting of the Council.

Walthamstow.—The Board of Trade have decided to grant the provisional order applied for by the Walthamstow District Council for powers to supply electricity within the area of their jurisdiction. This order will require confirmation by Parliament before it can become operative.

Windsor.—The Electric Lighting Committee have submitted to the Town Council the provisional order which has been granted by the Board of Trade in respect to the electric lighting of Windsor and Eton. Alderman Dewe moved the adoption of the report, Councillor Burt seconded, and it was agreed to.

South Africa.—An item from Johannesburg states that the directors of the Wemmer Company have sanctioned the following expenditure on capital account: (*a*) for additional 10 stamps to mill; (*b*) for electric lighting plant; (*c*) for addition to cyanide plant (two leaching vats); and (*d*) for equipping workshops.

Submarine Cables Trust.—The sum of £1. 15s., on account of the coupon due on Monday, will be paid by Messrs. Glyn, Mills, and Co. The coupons should be left with the bankers for examination four clear days before payment.

Newmarket.—The Board of Trade have revoked the Newmarket Electric Lighting Order, 1893, as confirmed by the Electric Lighting Order Confirmation (No. 7) Act, 1893, as from March 28, 1895, the revocation to take effect from such date.

City and South London Railway.—The receipts of the Company for the week ended April 14 were £779, against £840 for the corresponding week of 1894, or a decrease of £61. The total receipts for the current period of the present half-year are £14,362 against £13,727 in the corresponding period of 1894, an increase of £635.

Pemberton.—At an extraordinary meeting of the Urban District Council, Messrs. Gaskell and Sharrock attended as a deputation with reference to their proposal to put down a small electric lighting plant for a portion of the West Ward. The further consideration of the question was adjourned until the annual meeting.

Telautograph Company, Limited.—This Company has been registered, with a capital of £42,000, to carry on the business of a telautograph, telephone, telegraph, and electric light, heat, and power supply company, and, with a view to the above objects, to enter into an agreement with the Gray European Telautograph Company.

Leamington.—A committee of the Town Council have reported that they have received a letter from Mr. F. H. Medhurst asking the committee to give him an appointment to explain the system of electric light producer and refuse destructor, but at present they do not see any reason to accede to his request. The report was adopted.

Newcastle Tramways.—The Newcastle Town Improvement Committee have received a letter from the Board of Trade intimating that, having received and considered the report of the Government inspector, they had resolved to sanction the application of the cable haulage system to the Newcastle tramways, with certain slight modifications.

Pontypool.—The Board of Trade have decided to grant the provisional order which was applied for by the Pontypool Electric Light and Power Company, Limited, for powers to supply electricity within the district of the Pontypool Local Government Board. This order will require to be confirmed by Parliament before it can become operative.

Colwyn Bay.—Messrs. Clirehugh and Dune, engineers and local agents respectively for the proposed electric tramway between Llandudno, Conway, and Colwyn Bay, have attended a meeting of the Urban Council and explained the general nature of the scheme. They asked the Council to express their approval of the principle, which was done.

Epstein Accumulators.—The increasing demand for the Epstein accumulators has necessitated the erection of a new large factory, which is now in full working order, and comprises a plant of 600 h p, enabling the company to execute even very large orders expeditiously. At the same time the prices have been reduced. Enquiries should be sent to the head office, 215, Gresham House, Old Broad-street, London, E.C.

Change of Firm.—Messrs. Edlin and Stevenson of Church-street, Cape Town, inform us that Mr. Herbert W. Edlin has retired from their business, and that it is now being carried on under the same style by Mr. A. David Stevenson, who has taken over all assets and liabilities of the firm. It is requested that creditors will furnish a statement of accounts owing to February 28, and that all accounts due to the firm up to that date be settled at the earliest moment.

Wakefield.—The Electric Lighting Committee of the City Council have recommended that tenders for electric lighting works should be obtained, and that application should be made to the Local Government Board for power to borrow £25,000 to defray the cost of the works, which Councillor J. L. Lee hopes will be carried out with as little delay as possible. The Town Council have referred to the General Purposes Committee a letter on the subject of the electric light.

Snowdon.—The construction of a railway to the summit of Snowdon is making satisfactory progress. The severe weather of the early part of the year delayed operations for several months, the mountain being covered with deep snow. There are about 200 men engaged on the construction of the railway, and presently an additional number will be employed. Earthwork for about one-half the distance has been excavated, and the resident engineer, Mr. Oswell, expresses the opinion that the line will be in operation during the greater part of the tourist season this year.

Morecambe.—The Finance Committee have reported to the Town Council the receipt of a letter from the Morecambe Electric Light and Power Company, Limited, stating that the managers of the company were open to treat for the transfer of the company's undertaking and works on equitable terms, and that the letter had been referred by the chairman of the committee for consideration. It was resolved that the Chairman of the Committee, Messrs. W. H. Bellamy, T. Baxter, and W. Harper be a sub-committee to interview the managers of the electric light works upon the subject of the letter.

Taunton.—Alderman Spiller at a meeting of the Town Council called the attention of the Council to the fact that within six weeks the Bath and West of England Show would take place at Taunton, and yet the pavements were up and many works uncompleted. It was stated that the reason of the pavements being

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pulled up all over the town was owing to the fact that the electric light cables were being laid underground. Mr. Potter, chairman of the Electric Light Committee, assured the Council that all the work of laying the cables and readjusting the footpaths would be completed long before the show.

Huddersfield.—A meeting of the Town Council was held on Wednesday. The minutes showed that a deficiency arose on the revenue account of the electric lighting works of £2,065. 4s. 9d. Mr. Gee asked whether the chairman of the committee could give the Council some idea when the leakage of these works would cease. Mr. Calvert replied that they were in a better position than last year, when there was a deficit of about £2,000 for only a part of a year's working. Had it not been for the heavy rate of interest to be paid on the loans which covered a short period, there would be a profit on the works for the past year of £1,400. The minutes were approved.

Dover.—Several trials of the electric light have been made. The lights in the Town Hall were used for the first time at a Cinderella dance, and were most successful. The Dover Electric Light Company have commenced their contract for lighting a portion of the public thoroughfares of Dover by electricity. The lights used are arc lamps, and the section of the town included in their present contract is the whole of the sea-front and the main thoroughfare from the sea to the Market-place. Everyone admits that the light is very fine. The only public buildings at present lighted by electricity are the Town Hall and Buckland Church. The light was first used at the church on Easter Day.

St. Helens.—The chief clerk, Mr. Lee, reported to a meeting of the Water Committee that some time ago the Baths Sub-Committee decided to carry out certain repairs at the Warrington-road baths, but when the question was brought before the Water Committee it was decided to defer it, as the Gas Committee had expressed a desire to take over the baths premises for conversion into a building for the proposed electric lighting machinery. The Gas Committee, however, had decided that the baths would not be required. Alderman Cook said the premises were found to be unsuitable for electric lighting purposes, and the committee had decided to recommend the Council to close Rimmer-street, to pull down the cottages now therein, and to erect new electric lighting premises.

Aberdeen.—At a meeting of the Gas Sub-Committee of Aberdeen Town Council, representatives from Messrs. New and Mayne and Messrs. Shirras and Sons were heard with reference to a reduction in the charge for electric current supplied to motors. The deputation stated that several enquiries had been made on the subject, and the feeling was that the charge should be less than that for current for lighting purposes. The committee, in view of the fact that the current supplied to motors would be used mostly during the day, when very little lighting was required, agreed to recommend that the charge for the supply to motors should be 4d. per unit. It was resolved to recommend to the Gas and Electric Committee that a further lease should be taken of the shop in Union-buildings used as a gas-stove showroom, although there might be an increase of rent owing to improvements that are to be carried out.

Brechin.—The difficulty with the Scottish House-to-House Electric Lighting Company in regard to the agreement to supply electric light to the burgh has come up at a meeting of the Police Commission. A letter from the manager of the company was read with reference to the proposal that the Commission have the option to purchase the works at the end of 15 years, instead of at the end of 10 years, as first agreed upon. He said he had made enquiries as to the chances of the company obtaining financial support to carry out the undertaking, and found that such support would not be forthcoming unless the purchase could be made at the end of 15 years by arbitration, and not under the terms of the Electric Lighting Act. If this was agreed to, he thought the difficulties would be remedied. Bailie Ferguson thought that if they had the right to purchase at the end of 15 years it should be by Board of Trade terms, and moved accordingly. Mr. Jamieson seconded, and this was agreed to.

Dewsbury.—A report has been submitted to the Town Council by the Lighting and Water Committee containing the following, among other items: "March 18.—Fortnightly reports as to supply were read—viz., electrical energy 1,280 units. A payment of £908. 13s. 2d., being the final of 20 per cent. on their contract, retained for 12 months, was ordered to be made to Messrs. Siemens, electricians. April 1.—The electrical energy discharged was 1,265 units (in 10 days)." The Council agreed to allow discounts on electricity and gas accounts, and by special application two members of the electrical staff were retained without pay. Alderman Robinson, in moving their adoption, pointed out that the consumption of electric current had increased very much recently, notwithstanding that the days were getting longer. As to the minute in respect to the discounts to be allowed on gas and electric light accounts, it was passed, but not unanimously. Councillor Wilkinson seconded the motion, and the minutes were confirmed.

Cardiff.—A meeting of the Cardiff Lighting Committee was held on Tuesday, the mayor (Alderman P. W. Carey) presiding. Several applications for the electric lighting of private houses in Cathedral-road, Newport-road, Tredegarville, and Charles-street were received. The committee agreed to extend the mains up Newport-road as far as the corner of Castle-road, through Westgrove to Mr. Howell's new house at the lower end of Richmond-road, and through Charles-street to the baths in Guildford-crescent. The estimate for the Newport-road section was £1,500 and for the Charles-street section £360, and it was resolved that the Finance Committee be asked to arrange to borrow those amounts. Alderman Lewis remarked incidentally that the electric light in Cardiff was the weakest he had seen, and this he attributed to the opaque lamps. The Mayor stated that the opaque lamps were considered to be the best. Clear glass had been tried in the Hayes, and was a failure. Besides, Major Cardew, R.E., who came down from the Board in connection with the telephone wires, and was an expert on electricity, stated that the lamps and street-lighting at Cardiff were as good as any in the country.

Change of Address.—Messrs. Callender's Bitumen Telegraph and Waterproof Company, Limited, inform us that, owing to the great increase in the business of this company, it has been found necessary to remove the offices from their present address to larger premises which they have taken at 90, Cannon-street, E.C. In order to cope with their increasing business, the directors have appointed Mr. Theodor Petersen as assistant manager to Mr. T. O. Callender. Mr. W. Douglas Reid, who has been connected with the company for the past 10 years on outside works, has been appointed resident engineer to superintend the carrying out of all works in the home district, and will be found at 90, Cannon-street. The business in the Liverpool district will be in charge of Mr. F. A. Pocklington, whose office will be at Oldham-place, Renshaw-street, Liverpool. The work in the South Midlands and West of England will be in charge of Mr. George Barnard, whose office will be at 58, Water-street, Birmingham. Mr. Burton, whose offices are at Lichfield House, Wolverhampton, and Talbot-street, Nottingham, will be in charge of the North Midland district. Mr. W. Moir, whose address is 28, Charlotte-street, Ayr, N.B., will have charge of the firm's work in Scotland.

Appointments.—The St. Pancras Vestry require the services of a chief electrical engineer, competent to undertake the charge and management of the whole of the Vestry's generating and distributing stations and mains, and capable of designing and carrying out all extensions and new works in connection with the private and public lighting in St. Pancras Applicants are to state age and qualifications, and to forward copies of three testimonials (not originals). Salary £600 per annum. Applications to be sent to Mr. Pycraft, marked "Application for Chief Electrical Engineer," on or before May 2.—The Vestry of St. John, Hampstead, are prepared to appoint an electrical engineer to superintend the whole of their electric lighting undertaking in the above parish. His duties will be to take charge of the central electric light station, to prepare plans and estimates, and to superintend the carrying out of all future extensions of the undertaking in the parish. He must have actual practical experience of alternating-current central-station work. He must devote the whole of his time to the duties of the appointment, and will be required to reside in the parish. Salary to commence at £300 per annum. Applications, stating age and previous experience, together with copies of not more than three testimonials of recent date, to be addressed to the vestry clerk, and endorsed "Electrical Engineer," not later than May 2.

Southport.—A meeting of the Town Council has been held at which Councillor Hesford proposed the adoption of the minutes of the Electric Lighting Committee, who recommended the acceptance of tenders for engines, alternators, and cables. He had received a letter from Councillor Baxter asking questions as to the tenders which had been sent in, and in reply he had to state that as to the engines two tenders were invited, two sent in, and the lowest was accepted. As to the alternators, one tender was invited and it was accepted. It was not every machine which would work with those they had, and they were advised by experts that the machine recommended would tend to remedy the little difficulty they had experienced at the works. Councillor Todd seconded the motion. Councillor Baxter said he was surprised that an order amounting to £2,550 should have been given after inviting only two tenders. There were in Lancashire, not two, but about a dozen makers of the engines required, and from his knowledge of engines he knew that engines of equal power, if not a little more, could be obtained for £2,000. He was not prepared to vote for any such ridiculous sum, and he would propose that the minute be referred back to the committee. Councillor Holland seconded the amendment for the sake of discussion. Councillor Boocock supported the minutes. Councillor Hesford said it was an undoubted fact that they could buy engines of the same nominal power for less money, but who was to adjudicate. They were placing the order with a good firm upon whom they could rely, and the cost per horse-power would be somewhat less than the cost of their present engines. It was important that they should have one of their new engines running by September 15, and that would be secured by dealing with the present firm.

Middlesbrough.—The Electric Lighting Committee of the Town Council have recommended that the question of electric lighting should be deferred. Alderman Jones, in moving the adoption of the minutes, while agreeing with the recommendation, said that with the number of tradesmen who were prepared to adopt the electric light they could start with three times the number of customers originally obtained by the Corporations of Newcastle and Bradford. He would at the next meeting ask them to come to a definite decision, and either apply for a provisional order or cease to play the part of the dog in the manger. Councillor Baker seconded the motion. Alderman Hugh Bell thought they should start a relatively small station, which would cost between £10 000 and £20,000, and which would supply something like 3,000 lights. They could then feel their way in the direction of the demand which was likely to arise. They were nearly at the end of their tether with the gasworks, and the starting of such a station would relieve them from the important

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question of providing another gasmaking establishment. He moved that the Electric Lighting Committee should supply an estimate of the cost of a installation as he had suggested. Councillor Theo Ward seconded. Alderman Bulmer opposed the amendment, and said the light had failed to pay in several towns. Councillor Brewster did not think the committee were proposing a course which the Corporation should take. Alderman Jones said Alderman Bulmer was absolutely wrong in saying that the electric light in 20 towns had not paid. He suggested that Alderman Bell should withdraw his amendment, and said the committee would have something positive to bring forward at the next meeting. Alderman Bell withdrew his amendment, and the minutes were adopted.

St. Pancras.—At the St. Pancras Vestry meeting held on Wednesday, Mr. Churchwarden J. Thornley, J.P., presiding, the Electricity and Public Lighting Committee presented a statement of accounts for the year ending December 31 last, and drew attention to the very satisfactory result of the past year's working. The generating expenses in 1893 amounted to £6,103. 4s. 1d., and in 1894 to only £73. 5s. 10d. in excess of this amount, while the increase in the current sold to private consumers reached £2,510. 12s. After paying all charges for repairs and maintenance, including rates and taxes, there was an available balance of £7,233. 1s. 4d. to meet the interest and payments of the instalments off loans—viz, £5,379. 19s. 2d., comprising interest on the bank overdraft. Hence, there was a net profit on the year's working, after providing for bad debts, etc., of £1,753. 18s. 2d. This sum, with the amounts paid for interest and repayment of loans, was equivalent to a dividend of over 6 per cent. on the capital expenditure, and would be available for distribution to the shareholders if the undertaking belonged to a company. The committee considered that the sums paid off loans by St. Pancras in 1894 was equal to nearly 2 per cent. on the capital expenditure, and was equal to the sum set aside for depreciation by three London companies who were working on similar systems to that in St. Pancras, while if comparison was made with the total capital expenditure of the whole of the London companies it would be found that the amount set aside by them for depreciation was under 1 per cent. The charge for public lighting during the year, although more lamps had been erected, was reduced by £515. 16s. 11d. in one quarter owing to the charge being reduced from 6d. to 5d. per unit. Current sold to private consumers at 3d. per unit realised £1,236. 13s. 9d., and at 6d. £10,819. 15s. 9d. At the instance of Mr. A. Sweet, chairman of the committee, the report was adopted, after an expression of satisfaction on the part of the Vestry that it possessed so prosperous a commercial undertaking, which it was estimated could now be sold at a profit of £30,000.

Edinburgh.—A special meeting of the Edinburgh and Leith Gas Commissioners was held on Tuesday, Lord Provost M'Donald in the chair. Councillor Mackenzie, who attended at the request of the Lord Provost, made a short statement to the Commission in his capacity as convener of the Edinburgh Corporation's Electric Light Committee. There was, he said, a slight explosion in Frederick-street, in reference to which a letter had been received saying that the gas leak was due to the operations of the electric light department. They did not deny that. They were quite willing to admit that such leaks had been caused. It could not have been otherwise with operations of such magnitude. But what he wanted to point out was this, that under the new condition of things the method that had hitherto been in use in looking for leakage with naked lights was very dangerous, not only to the public, but it might also cause great damage to the electric mains and interruption to the current. They, therefore, hoped that the Commissioners and their engineers would issue instructions that some other method should be adopted of looking for leaks. They were not dictating in any way; but they were most anxious that everything should be done to prevent the risk of explosions. Bailie Kinloch Anderson assured Mr. Mackenzie of the co-operation of the Gas Commissioners. As a matter of fact, the engineers had instructed the men not to use naked lights, but in the case referred to that had been disregarded. The engineers would issue fresh instructions, so that such a thing would not occur again But he would suggest to the Electric Light Committee that the culverts and manholes should be ventilated, and if that were done he thought it would obviate risk of explosion. In reply to a commissioner, Bailie Kinloch Anderson said the only other way of looking for a leak was by smell. Councillor Mackenzie said they were under obligation to the Board of Trade to ventilate the manholes, but it appeared that certain of the explosions which occurred in London were in comparatively open and ventilated places. In consequence, the opinion of the Board of Trade inspector, Major Cardew, had been entirely changed, and his view now was that immunity would be best secured by plugging up the ends of the culverts so as to prevent the gas from travelling, and by filling the box with some non-combustible material so as to prevent the gas from accumulating. That was now being done in Edinburgh.

Ealing.—The Electric Lighting Committee have reported that the surveyor had informed them that he had attended the electric light station, and formally, on behalf of the Council, taken over the working. Messrs. Bramwell and Harris had written that as the electric light works under the original contracts were virtually completed, their further association with the Council professionally in the matter would be as consulting engineers, and they suggested an appointment for five years at £105 per annum. The committee had come to the conclusion that for some time to come the services of an experienced consulting engineer would be necessary, and they recommended the appointment of Messrs. Bramwell and Harris for a term of three years at £105 per annum, this fee to include all travelling and incidental expenses A letter had been received from Messrs. Callender and Co. relative to damage done to the centre arc posts by carts coming along the road with the drivers fast asleep, and it had been decided that the matter should be brought to the notice of the police. The committee further reported the consideration of a letter from the Brush Company regarding the laying on of current to a house in North Common-road. The committee considered that a main should be laid on so as to serve this particular road; the line of main would be from the transformer on Ealing Green, along the Grange-road and the west side of the common to Uxbridge-road. This course would enable several houses to be taken on the route, would deal with the several road lamps, and provide for the lighting of the whole of the North Common-road. The supply would be for about 1,200 8-c p. lamps, and the cost about £650. The committee recommended that this work be proceeded with. A letter had also been received from Mr. Stuart asking that his house in Florence-road might be connected with the main. As the house was outside the specified distance, Mr. Stuart offered to pay the excess amount of £30, the money to be refunded to him in three annual payments. The committee recommended that this be done. Mr. Pritchard moved that the appointment of Messrs. Bramwell and Harris as consulting engineers be deferred until after the final settlement of the accounts in connection with the electric lighting works. The other members of the Council appeared to feel that nothing was to be gained by this proposal, and it was not seconded. The report of the committee was then adopted. A proposed improvement (suggested by Mr. Green) in the roadway on Ealing Common, to be carried out in connection with the contemplated laying of an electric light main, was referred to the Works Committee for consideration; and a plan suggested by Mr. Hedges for the better protection of the centre road electric lighting lamps was referred to the surveyor, who expressed his opinion that the plan proposed would be a very good one in more effectually protecting the standards and the erections on which they were placed. A communication from the parish of St. Mary, Islington, regarding explosions in electric lighting conduits through escapes of gas from gas-mains, was referred for consideration to the Electric Lighting Committee.

Croydon.—The General Purposes Committee of the Croydon County Council have presented the following report: '(*a*) That the Electric Lighting Sub-Committee be authorised to instruct the town clerk to make application to the Local Government Board for permission to borrow a sum not exceeding £27,500 for the purpose of electric lighting. (*b*) That the sub-committee be authorised to instruct Prof. Kennedy to arrange with the British Thomson-Houston Company a detailed specification of such works as in the judgment of Prof. Kennedy will satisfactorily supply electricity to the central area, together with all necessary accessories at such contract price as Prof. Kennedy may approve. Provision will be made, as far as buildings and laying pipes to carry extra mains are concerned, for a considerable future extension of the system. (*c*) That the sub-committee be authorised to order the corporate seal to be affixed to a contract with the British Thomson-Houston Company, Limited, subject to the sanction of the Local Government Board to a loan for the purpose of providing the necessary expenditure. (*d*) That in the event of the British Thomson-Houston Company, Limited, not being willing to enter into a contract for carrying out the revised specification at a price which is satisfactory to Prof. Kennedy, the sub-committee be authorised to abandon negotiations with that company and to enter into fresh negotiations with the firm whose tender is above referred to, reporting, however, to the Council before any contract with that firm becomes binding. (*e*) That the sub-committee be authorised to engage Prof Kennedy to watch the interests of the Corporation in the matter and to see that the contract is efficiently carried out. (*f*) That the sub-committee be generally authorised to make such arrangements for carrying out an installation for the central area as they may find necessary or expedient." The committee have added the Mayor and Alderman Thrift to the sub-committee. After a lengthy discussion the report was adopted. The usual monthly meeting of the council of the Croydon Chamber of Commerce has been held, at which the assistant secretary presented a report detailing the result of the canvass recently undertaken by the Chamber in reference to the electric lighting question, with a view to ascertaining the views of the residents in the compulsory area and in the locality immediately contiguous as to the amount of support the electric light would be likely to receive if introduced into the town, and as to whether the opinion of the traders of the town is in favour of the undertaking being worked by a private company or by the Corporation The replies received from the whole of the residents addressed both inside and outside the compulsory area may be totalled as follows as being the net result of the canvass: total number of circulars sent out, 804; total replies received, 369; number who replied yes to the question, "Would you be likely to use it?" 146; number who replied with a qualified "yes," such as "Depends on the price," 74; number who replied "no," to same question, 121; in favour of the Corporation carrying out the works, 244; in favour of a private company, 53. Replies in the affirmative in answer to the first question have been received from the representatives of the following: Public Hall, Croydon National Hall and Circus, Girls' High School, Croydon Theatre Royal, Croydon Conservatoire, and the churches of St. Matthew and St. Michael and all Angels, the Free Christian Church, and St. Mary's Catholic Church.

Weston-super-Mare.—A meeting of the Urban District Council has been held at which a report was presented showing that at a

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committee meeting of the whole Council, held on 4th inst., a letter dated March 29 was received from Mr. F. H. Medhurst proposing that the electric lighting provisional order be transferred to a company, to be formed forthwith by himself, on the following conditions—viz.: (1) The company to pay the Council 400 guineas for the provisional order on the signing of the agreement between the Council and the proposed company. (2) The Council to have the option of purchasing the undertaking at the end of five years, and at the end of every subsequent period of two years. (3) In the event of the Council exercising the first option, the amount to be paid by the Council to the company to be equivalent to the amount expended by the company plus a bonus of 15 per cent.—in other words, the Council would, in the event of its exercising its option at the expiration of five years, pay the company £115 for every £100 of capital legitimately expended by the company on the undertaking. If the Council decide to purchase the undertaking at the end of seven years, or at the end of any subsequent period of two years, the amount to be paid to be equivalent to the capital expended by the company plus a bonus of 10 per cent. If the Council purchase the undertaking at the expiration of 42 years, then they would pay the then value of the undertaking without any allowance whatever for goodwill or compulsory purchase. (4) The company to undertake not to charge more than 6d. per unit for private lighting. (5) If the Council decide to entrust the company with public lighting the amount to be paid by the Council to the company per arc lamp of 2,000 c.p. per annum to be £20. But it shall not be compulsory for the Council to give the company any public lighting whatever. (6) The Council to undertake to supply the company free of charge with all the refuse of Weston-super-Mare, and to pay the company the sum of £60 per annum for thoroughly disposing of the same without creating a nuisance in a suitable refuse destructor. At present the cost to the Council is about £60 per annum for pumping, wages, etc., at the refuse pits. The above conditions apply to the electric lighting and refuse destructor schemes, but the company would be prepared, with the consent and approval of the Council, to apply for a tramway provisional order from the station to the pier, and to lay down immediately on receipt of the said provisional orders a suitable electric tramway for that distance. It is understood that in the event of the Council exercising the first or any of the options for pre-emption, the same conditions would apply to the tramway as to the electric lighting and refuse destructor schemes, and the Council would be bound to purchase the whole undertaking of the company in its entirety whenever they decide to exercise their option. Whilst the company would be willing and even anxious to carry out the electric tramway above mentioned, it would, nevertheless, not make this part of the scheme a *sine qua non*, and would be prepared, if the Council preferred, to carry out the electric lighting and refuse destructor scheme alone. Mr. Medhurst's letter concluded by stating, "I shall be pleased to have an early opportunity of discussing this question with your Council, and I wish especially to point out that my offer is not in any sense to be taken as an ultimatum, but that it is capable of modification if such modification is thought necessary by the Council and is considered possible by me." It was proposed by Councillor Gill and seconded by Councillor Dubin, "That in the opinion of this committee it is not desirable that the Council should transfer the powers, etc., conferred upon them by their electric lighting provisional order, but should retain same in their own possession in order to carry them out as soon as they consider themselves in a position to do so." It was proposed by Councillor Deverell, and seconded by Councillor Phillips, "That before we proceed to vote on this question, Mr. Medhurst be invited to come into the Council-room." This being lost by eight votes to six, the original motion was carried.

PROVISIONAL PATENTS, 1895.

April 8.

7142. **Improvements in regulating transformers for alternating currents.** Manchester Edison-Swan Company, Limited, Alfred Still and Edward Woodrowe Cowan, Temple-chambers, Brazennose-street, Manchester. (Complete specification.)

7147. **Improvements in telephone receivers.** John Graham, 46, Belmont-street, Haverstock Hill, London.

7152. **Improvements in the mode of and means for writing by telegraphy, which he terms the pantelegraph.** Julius Victor Faber, 77, Colmore-row, Birmingham. (Complete specification.)

7191. **Improvements in electric arc lamps.** Henry James Fisher, 70, Chancery-lane, London.

April 9.

7245. **Improvements in electric railways.** John Henry Guest, 52, Chancery-lane, London. (Complete specification.)

7278. **Improvements in or relating to electric conductors.** Christian Hamilton Gray, 323, High Holborn, London.

April 10.

7315. **Improvements in and connected with electrical storage batteries.** William Joseph Starkey Barber-Starkey, 70, Market-street, Manchester.

7364. **Improvements in the electrolytic manufacture of alkali-chlorates.** Jasper Wetter, 433, Strand, London. (The Elektrizitäts-Aktiengesellschaft vormals Schuckert and Co., Germany.)

7319. **Improvements in and relating to electrical hot-plates.** Thomas Fletcher, William Russell, and Fletcher Russell, and Co., Limited, 70, Market-street, Manchester.

April 11.

7445. **Improvements in accumulators.** Daniel Edward Hipwell, 8, Quality court, Chancery-lane, London.

7458. **Improvements in the electrolysis of metallic salts.** Carl Kellner, 46, Lincoln's-inn-fields, London.

April 13.

7504. **Improvements in and relating to the distribution of alternating currents.** Galileo Ferraris and Riccardo Arnó, 45, Southampton-buildings, Chancery-lane, London.

7525. **An electrical jacquard apparatus for use in curtain-lace machines and fancy looms.** William Sissling, 25, Prince-street, Long Heaton, Derbyshire, R.S.O.

7548. **An electric safety switch.** Siemens Brothers and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1894.

5863. **Electric fuse-boxes.** Reason.
6315. **Electric controlling device.** Shepard.
7050. **Electrically-illuminated signs.** Fricker.
9534. **Electric accumulators.** Kolbe.
9565. **Fixing electric insulators.** Gray.
9647. **Telephones.** Nicolson.
14492. **Electric light photography.** Adamson.
15129. **Evacuating incandescent lamp bulbs.** Malignani.
17498. **Electric alarm clocks.** Benest.
19934. **Galvanic batteries.** Hübner.
22637. **Electric uterine battery.** Hebard.

1895.

1949. **Mat and electric alarm contact.** Pye.
2333. **Using electric light for photography.** Adamson.
3062. **Electric locomotives.** Boynton.
3086. **Telegraphic apparatus.** Lake. (World Flash Company.)
3358. **Electric railway systems.** Wheless.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅛-5⅜
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅛-2⅜
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5-5⅛
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	15-15½
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	130-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	100-105
Electric Construction, Limited	2	⅛-⅛
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1⅛-1⅜
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅛-1⅛
Elmore's French Company	2	—
Elmore's Wire Company	2	1⅛-1⅛
Fowler-Waring Cables	5	⅛-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	9⅛-10⅛
—— Preference	—	12
House-to-House Company, Ordinary	5	3⅛-4
—— 7 per cent. Preference	5	7⅛-7⅛
India Rubber and Gutta Percha Works	10	21⅛-22⅛
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge	5	7-7⅛
—— 6 per cent. Pref.	5	7-7⅛
Liverpool Electric Supply, Ordinary	5	7⅛-7⅜
—— Pref.	—	—
Liverpool Overhead Railway	10	8⅛-8⅜
—— Pref.	10	14-14⅛
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	⅛-⅛
Metropolitan Electric Supply	10	9⅛-10⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5⅛-5⅛
—— 6 per cent. Cum. First Pref.	10	15⅛-16⅛
—— 6 per cent. Cum. Second Pref.	10	14⅛-15⅛
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7⅛-7⅜
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7⅛
—— £4½ shares	4½	5⅜-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅛-8
—— 7 per cent. Pref.	5	8⅛-9
Swan United	—	—
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	105-108
Westminster Electric Supply, Ordinary	5	7⅛-8⅛
Yorkshire House-to-House	5	5⅛-5⅜

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NOTES.

The Chitral Expedition.—The field telegraph has been in use in connection with these operations.

Personal.—Mr. E. O. Walker, C.I.E., has entered upon his duties as superintendent of telegraphs, Ceylon.

Tramways (Local Authorities) Bill.—This Bill has been read a second time in the House of Commons.

Municipal Electric Lighting.—Various London vestries are accused by *London* in its last issue of apathy in the matter of progress as regards electric lighting.

Exhibition at Paris.—It is intended this year to hold an International Sanitary Exhibition in Paris. The offices are at 103, Boulevard Haussmann, Paris. Class 2, dealing with municipal hygiene, includes an electricity section.

Electric Traction in France.—The first trials on the electric tramway line at Lille have taken place on the portion between the Laboureur Bridge and the Palace de Wattrelos. The whole system will be in operation shortly.

Electric Lighting in Switzerland. — The Uri authorities are considering an application of Mr. Usern to utilise the power of the Oberalpreuss for the electric lighting of Andermatt and Hospenthal, and for electric traction purposes.

Electric Traction in Germany.—Authority has been received by Messrs. Siemens and Halske for an electric tramway in Berlin from Warschauerstrasse to Nollendorfplatz and Potzdamerplatz. This is to be an overhead railway.

"What's in a Name?"—Mr. Nelson W. Perry, the well-known American electrical engineer, is designated in a gas contemporary as Melsoon W. Perry. But one does not expect accuracy from a gas paper when it touches upon anything of an electrical character.

Telegraphy in India.—India and China are now in direct telegraphic communication *viâ* Bhamo and Moulmein. The telegraph line between Kulu and Mundi has been thoroughly repaired and re-aligned. The new line being shorter, a saving in material has been effected.

Electro-Medical Instruments.—We have received from Messrs. A. Hurst and Co., 66, Fenchurch-chambers, E.C., a catalogue of their electro-medical instruments, including galvanic batteries, portable constant-current batteries, etc. There is nothing of the "Harnessing electricity" about these.

Students' Meeting.—A meeting of the students of the Institution of Electrical Engineers will be held in the library of the Institution, 28, Victoria-street, on Friday, May 3, 1895, at 8 p.m., when the following paper by Mr. A. C. Eborall will be read: "Single-Phase Alternate-Current Motors" (with illustrations, etc.).

Foremen Engineers.—The anniversary dinner of the London Association of Foremen Engineers and Draughtsmen will be held to-morrow (Saturday), in the Great Hall, Cannon-street Hotel, at 6 p.m. The chair will be taken by the Right Hon. H. Campbell-Bannerman, M.P., whilst Mr. Alexander Siemens, M.I.C.E., will occupy the vice-chair.

Institution of Electrical Engineers.—No. 116 of the *Journal* of the Institution has been issued. Among other matter, it contains the papers by Mr. W. B. Sayers on "Reversible Regenerative Armatures and Short-Air-Space Dynamos," and by Dr. John Hopkinson on "Propagation of Magnetisation in Iron," and the discussions thereon.

Holborn Restaurant.—A well got-up illustrated *brochure* has been issued by the proprietors of the Holborn Restaurant, the letterpress being by Mr. Frederick Leal and the illustrations by Mr. Horace Morehen. As our readers probably are aware, the establishment is lighted electrically throughout, and among the illustrations is one of the machinery-room.

School-Lighting.—At the Sanitary Conference which was opened at Manchester on Wednesday, Dr. Emrys Jones read a paper on "The Lighting of Schools," in which he urged the adoption of the electric light in schools. In the course of the discussion, the chairman, Dr. Maclure, expressed concurrence in the view that the electric light should be used in preference to gas.

Electric Lighting in Hungary.—Messrs. Egger and Co. are fitting up a private installation in the Königs Brewery in Budapest, which is one of the largest breweries in the country. The plant is at present to be for the supply of current for 1,200 incandescent lamps and for various electric motors.—A limited liability company has been formed for the erection of a central station at Ujhely.

Electric Transmission in Germany.—For a long time there has been a scheme spoken of for the establishment of a central station near Berlin for the service of the various villages of the Upper Spree. The consent of the local authorities has now been obtained, and the Allgemeine Elektricitäts Gesellschaft will proceed with the work. The main object of the installation is to supply power to manufacturers.

The "Desecration" of Nelson's Column.—The *Daily Chronicle* states that as the result of action taken by the local authorities, in conjunction with the Office of Works, the "desecration" of Nelson's Column and public buildings in Trafalgar-square by advertisers, by means of search-lights, has been stopped. If this statement be true, it shows somewhat absurd sentimentality on the part of the Office of Works.

Rating of Machinery Bill.—The fact that the Rating of Machinery Bill passed through Grand Committee at a single sitting without alteration has not modified the opposition with which it is regarded in some quarters. When it comes on for third reading Mr. James Lowther will move that it be recommitted to a committee of the whole House. Mr. Powell Williams, going a step further, will move its rejection.

Gray's Improved Telautograph. — We are informed by the General Electric Company, Limited, that a line for the transmission of handwriting by this machine, has now been erected between their warehouses, 69 and 71, Queen Victoria-street, E.C., and the offices of the Telautograph Company, 13, Victoria-street, S.W., (a distance of from two to three miles), at either end of which is a transmitting and receiving instrument.

A Marvellous Incident. — Several daily papers report a phenomenon as follows: "Electric Fuses Explode.—An alarming explosion occurred yesterday afternoon on the premises of Mr. A. W. Bennett, electrical engineer, East-parade, Leeds. It appears that a number of fuses which were being packed suddenly exploded, causing a report which was heard for a considerable distance, and seriously injuring a youth named Humphreys."

Electric Lighting in Bombay.—The *Times of India* says that proposals for lighting the residency, "Westward Ho," the Holy Trinity, St. Mark's, St. Andrew's, St. John's, the Wesleyan Churches, and several regimental messes with electric light are now under favourable consideration, and Mr. Simpson, superintending electrician of the Oriental

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Electric Light Company, has been asked to survey the residency, churches, etc., and to submit estimates.

Books Received.—We have received from Messrs. Crosby Lockwood and Son, of Stationers' Hall-court, E.C., "Electric Light for Country Houses," by Mr. John Henry Knight. It is described as a practical handbook on the erection and running of small installations, with particulars of the necessary cost of plant and working. Messrs. Longmans, Green, and Co. have published "Motive Powers and their Practical Selection," by Mr. Reginald Bolton.

Light Railways.—According to recent returns, light railways are a decided success in Sweden. The quinquennial return just issued shows that the average earnings of the Swedish light or narrow-gauge railways is £140. 15s. 6d. per kilometre, and the traffic expenditure £82. 11s. 6d., leaving a net surplus of £58. 4s. The average cost of construction has been £1,681 per kilometre, so that the return on the capital expended should have averaged 3·46 per cent.

Society of Arts.—The arrangements for next week are as follow: on Monday, 29th inst., Cantor Lectures; "Recent American Methods and Appliances Employed in the Metallurgy of Copper, Lead, Gold, and Silver," by Mr. James Douglas—(Part II., "The Calcination of Ores and Chlorination of Gold and Silver); and on Wednesday, May 1, "Deviations of the Compass," by Prof. A. W. Reinold, when Dr. W. Anderson, F.R.S., vice-president of the society, will preside.

New Instrument Wanted. — Lieutenant-Colonel Yorke, who has issued his report to the Board of Trade on the Great Northern Railway accident at Wood Green, says: "What seems to be required is some test, possibly either by means of electricity or sound, which could be readily applied at suitable intervals to each individual axle, by which it can be ascertained whether the axle is structurally perfect throughout." It would be interesting to know what has become of the schiseophone.

Bordeaux Exhibition.—The London Chamber of Commerce are informed that it is officially announced in Bordeaux that the Bordeaux International Exhibition will be open to the public on and after Saturday, May 4, and intending exhibitors who have already had space allotted to them, but have not yet sent their goods to Bordeaux, are reminded that if exhibits are not received at Bordeaux in due time, the exhibition authorities will consider themselves at liberty to dispose of such space otherwise.

Imperial Institute.—Saturday, May 11, was fixed at the last meeting of the executive council for the opening of the summer season, and it was reported that the whole of the available space for the exhibition of railway appliances and inventions had been allotted, and that it had been impossible to meet several applications. It was announced that progress had been made with the arrangements for the exhibitions of photography in its relation to art, science, and industries, and the collection of the Duc d'Orleans.

Explosions.—An interviewer of the *City Press* has been discussing Major Cardew's Southwark Bridge report with a gentleman who is vaguely described as "the secretary of a well-known electric lighting company." Internal evidence shows that he is an official of the City of London Company. The anonymous gentlemen interviewed came to the conclusion that the gas companies ought to be under the supervision of the Board of Trade as well as electric lighting companies, and should be obliged to take measures to prevent the escape of gas.

Electrical Engineering in Persia.—With reference to the Persian concessions that have been made to Americans, the American Vice-Consul General at Teheran reports to the State Department that an American citizen holds concessions for drilling artesian wells for irrigation purposes throughout Persia, and for the introduction of electricity in its various forms outside of telegraphy, which already exists in that country. The concessionaire has not, however, been able to secure sufficient capital to push these enterprises to a successful issue.

Electric Cooking and Heating Apparatus.—The Electrical Company, Limited, 122 and 124, Charing Cross-road, send us an illustrated catalogue of their electric cooking and heating apparatus. It commences with general remarks on the subject for the benefit of the general public, together with instructions. The list includes electric hot-plates, plate-warmers, electric boilers (for being dipped into the liquid to be heated), pans, frying-pans and saucepans, coffee-cans and tea-kettles, grills, flatirons, cooking-stoves of various designs, cigar-lighters, etc.

South Africa.—A meeting of the Durban Town Council has been held at which the Finance Committee recommended that the necessary steps be taken for the issue of a loan of £100,000, at 4 per cent., to be placed in the London market for carrying out the electric lighting for the town, purchase from the War Department of lands for the construction of a bay esplanade, and the completion of the Umlaas Waterworks. After a long discussion, in which some members seemed disinclined to support all the projected improvements named, as representing too large a programme, the question was referred to a committee of the whole Council.

West of Scotland Iron and Steel Institute.—The annual general meeting of the West of Scotland Iron and Steel Institute was held last Friday evening in the Andersonian Buildings, Glasgow, Mr. James Riley, president, in the chair. The report by the council bore that 41 members had been admitted during the session, and after allowing for removals from various causes there was a net gain in membership of 31, the total on the roll being 187 members. In every way the session had been a gratifying success. Prof. A. Humboldt Sexton was elected president for the ensuing year. Mr. George Ritchie afterwards read a paper on water gas.

Electric Lighting at Rangoon.—A new Government house is being completed at Rangoon for the Chief Commissioner of Burma. The whole building is to be lighted by electricity. The entire plant has been ordered through the Secretary of State. The Irrawaddy Flotilla Company have the contract for fitting up the installation, and have laid all cables and wires throughout the house. With reference to the tenders which are being invited for the electric lighting of Rangoon, *Indian Engineering* states that it will have to be done by a concession to a reliable company, as the municipality cannot afford to meet its cost at present out of revenue derived from taxation.

Transmission of Power.—We understand that Mr. W. C. Johnson, of the firm of Johnson and Phillips, is about to lay down a transmission of power plant in Wales. Mr. Johnson has taken great interest in the gold-mining industry in Merionethshire, and has secured several claims. To develop these he proposes to utilise the water power of a small salmon stream, and to transmit some 200 h.p. to the mines of an electrical plant somewhat similar to that recently supplied by the firm to the Sheba Gold Mining Company. The distance of transmission will be about two miles. At present a five-stamp mill is being fixed, but this will be added to should sufficient payable ore be found.

Playing Tricks.—A Dover paper is responsible for the suggestion that the electric light manager there is a

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practical joker. The other Sunday night, the story runs, about 9 o'clock, "the promenaders on the sea-front were somewhat startled at the sudden disappearance of the electric light, all the lamps almost instantaneously ceasing to cast their light upon the scene. The stoppage naturally caused much comment, but tongues were soon set at rest by the reappearance of light in a few minutes, as brilliant as before. The cessation was not due to any fault in the machinery, or any defect in the wires, but was simply the result of an experiment on the part of the manager of the company. He wished to show the public the difference between the new illuminant and gas, and took this method of demonstrating it. A similar experiment was made at the Town Hall during the Primrose League 'At Home.'"

Mitchell's Newspaper Press Directory.—We have received a legal notice from Messrs. McKenna and Co., on behalf of Messrs. Mitchell and Co., that our note on this directory in our issue of April 5 is incorrect. We sorrowfully acknowledge that we were incorrect so far as to the remarks concerning *Electricity* and *Lightning*. The titles of these publications really do appear, first in the list of contents, where *Electricity* is given as a monthly—which of course it is not—secondly, among "Class Papers and Periodicals," where, however, *Lightning* appears as *Lighting*. We fallible mortals thought to find the names under the head of London papers, p. 41—but we suppose the *Electrical Engineer*, *Electricity*, and *Lightning* are not London papers. The titles are not found among the list of weekly newspapers (p. 33) nor among the papers published in London (pp. 66 and 72). We regretfully acknowledge our error in not seeking the titles of what we deem weekly trade papers—among the list of "magazines, reviews, and periodicals."

A Discoverer.—Mr. C. A. Pearson, of *Pearson's Weekly*, is a great discoverer—by which, of course, we do not mean a great inventor. But from time to time he discovers and publishes accounts of most marvellous inventions. His latest "find" is an inexhaustible primary battery. He, or one of his subordinates, writes: "The invention of the portable incandescent lamp some years ago promised to be of the greatest service to men who habitually travel in the semi-darkness of our English railway carriages. In this, however, we were disappointed. The constant necessity of sending the accumulators to be recharged made what would have otherwise been a luxury into a nuisance. Mr. H. F. Phillip, of Guildford, has now patented a pocket primary battery, designed especially with the intention of overcoming this difficulty. His battery is precisely the same size as the ordinary accumulator, but requires absolutely no recharging, acids, or attention. It is equally useful, of course, for motors, bells, medical coils, telephones, and so on. The strangest part of this invention, to my mind, is the fact that it is new." But supposedly inexhaustible primary batteries are not new. Mr. Pearson for a time ran *Industries and Iron*, and should therefore really know better.

Wood a Double Refractor for Hertzian Waves. Herr K. Mack, working in the Hohenheim Physical Institute, has succeeded in demonstrating the occurrence of double refraction of electric waves in wood. That electric waves, unlike light waves, are capable of penetrating wood was already found by Hertz. "It is not without surprise," he says in his classical work on the "Propagation of Electric Force," "that one sees the sparks appear inside a closed room." But the fact that waves of electric force are transmitted in a different manner accordingly as they vibrate across or along the fibre of the wood has only just been proved by Herr Mack, who gives a full description of his method in a recent number of *Wiedemann's Annalen*. It is well known that two Nicoll prisms transmit no light when their principal plates are crossed, but that light may be made to appear by inserting a doubly-refracting substance between them. For the Nicoll prisms substitute Hertzian concave mirrors with their focal lines crossed, and, instead of the tourmaline or other doubly-refracting substance, insert a plate of wood 10in. thick, with its fibre at 45deg. to each of the focal lines, and you have Mack's apparatus. The sparks, which are extinguished on crossing the two focal lines, reappear on inserting the wood in the manner indicated. This striking experiment forms another important link in the chain connecting the domain of light with that of electricity.

Mining Institute of Scotland.—The eighteenth annual meeting of the institute has been held at Hamilton, Mr. George A. Mitchell, president, in the chair. The council's report for the past year showed substantial progress, the membership being 487, against 481 last year. The expenditure had exceeded the income chiefly owing to unexpected calls from the federation. The balance on hand was £127. 19s., as against £155 last year. The office-bearers, as nominated at last meeting, were elected, and the president returned thanks for his re-election, and delivered an address, in which he dwelt on the importance of the institute in the discussion of mining matters. He referred to the loss since last meeting of Mr. Archibald, Cambuslang, a member of council, and a memorial minute to be sent to deceased's widow was approved of. Mr. James Wallace, Wester Gartshore Colliery, Kirkintilloch, was nominated as his successor for election at next meeting. The president, instead of delivering a formal address, read a paper entitled "Electric Coal-Cutting at Glenclelland Colliery." The discussion of the paper was adjourned. Brief discussions took place on papers read at a former meeting by Mr. A. M. Grant on "Winding Engines," and Mr. J. G. Barclay on "The Barclay Crown Valve Exhaust Gear" and an "Overhanging Beam Pumping Engine," and were adjourned. The secretary, in the absence of the author, Mr. Dugal Baird, read a paper on "Pumping-Engine Velocity Diagrams." The discussion was adjourned.

A Large Electric Locomotive.—In the March number of the *Transactions* of the American Institute of Electrical Engineers is a description by Dr. Cary T. Hutchinson of a large electric locomotive which has just been finished by the Baldwin Locomotive Works. This locomotive has eight drivers connected rigidly by side bars, making a wheel base of 16ft., the length over all being about 30ft. The weight is 133,000lb., uniformly distributed on the eight drivers, giving 16,700lb. on each driver. There are four motors, one on each axle, the motors being built directly on the axle without springs of any kind between the armature and the axles. The machine has a capacity on a four-hour test of 1,000 h.p. at a speed of 35 miles per hour. The regulation is the series-parallel, the motor being (1) all in series, (2) two series by two in parallel, (3) all four in parallel. There is also a resistance intended for use on first position in starting. The lowest speed, without resistance, is about seven miles per hour. A test recently made at the Baldwin Locomotive Works showed an efficiency of more than 92 per cent. when operating 1,000 h.p. The motors are designed so that they will work without sparking with full current in the armature at one-half normal field strength. That is to say, they will operate at any speed from 35 miles per hour up to about 65 miles per hour at the same power, the drawbar pull varying inversely as the speed. At speeds below 35 miles per hour the drawbar pull is constant, the power, therefore,

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being directly proportional to the speed. The smoothness and absence of vibration was very noticeable in the test referred to. The entire machine was supported on four jacks without bracings; when running with full torque there was scarcely any shaking.

New Arc Lamp.—Mr. Henry Chapman, 69, Victoria-street, S.W., is introducing into this country the Wilbrant arc lamp, made by a Brussels firm. The mechanism feeding and regulating the carbons is simple, there being no gearing, cords, or chains. The lamp consists of a frame of two stout brass rods, terminating in flat plates top and bottom. The lower plate supports a small electromagnet, through the core of which passes the shank of the lower carbon-holder. When no current is passing through the lamp this holder and its armature are forced away from the magnet by a spring, thus bringing the lower carbon into contact with the upper one. When a current passes through the lamp, the magnet pulls the holder down against the resistance of the spring, striking the arc. The feeding is regulated by a second electromagnet affixed to the upper cross-head. This magnet is also tubular, and the upper carbon-holder could pass freely through it were it not locked in position by the armature of the magnet. This armature is in the shape of a disc, with a hole through it for the carbon-holder to pass. It is kept away from its magnet by a spring, the strength of which can be adjusted to suit requirements, and is also forced against the carbon-holder by a second spring, which tilts it slightly, causing it to bind on the carbon-holder. The electromagnet is arranged as a shunt to the lamp circuit, and normally the current passing through it is not powerful enough to draw down the armature in opposition to the spring holding the latter up. If, however, the length of the arc becomes too long, thus increasing the resistance in the lamp circuit, more current passes through the electromagnet, the armature is then drawn down, carrying with it the carbon-holder, and re-establishing the arc at its proper length. The current through the magnet then falls again below the point at which it is able to attract the armature, and the latter flies back, but is unable to carry with it the carbon-holder, as the weight of the latter is opposed to the motion.

City and Guilds of London Institute. — The report of the council on the work of the institute for the past year has just been issued. At the Central Technical College the number of students has increased, but the present laboratory and workshop accommodation does not allow of any material increase in the number of students in the engineering and physical departments. The diploma of associate of the City and Guilds of London Institute was awarded to 14 students in physics and engineering, and to 13 in civil and mechanical engineering. The highest place in the class list was taken by F. Maeers in the engineering department, and the highest place in the physics department by H. C. Leake. Both of these students were awarded a Siemens Memorial Medal, Lady Siemens having kindly allowed the die of the medal originally presented to the first student in the physics department only to be used also for the first student in the engineering department. At the Technical College, Finsbury, the attendance has fallen off. The decrease was due to the smaller number of second-year students in the mechanical and electrical departments, a larger proportion than usual of first-year students of the previous session having failed to obtain promotion to the second-year course. At the close of the session certificates were awarded nine students in mechanical engineering and applied mathematics, and 23 in applied physics and electrical engineering. The Sir David Salomons scholarship, administered by the Institution of Electrical Engineers, was also won by a Finsbury student. During the year the equipment of the electrical laboratory has been increased by the purchase of the polyphase apparatus used for the transmission of power at the Frankfort Electrical Exhibition. The Mordey alternating dynamo in the electrical laboratory and the new testing machine in the mechanical laboratory, erected at the beginning of the year, and referred to in the Council's last annual report, have proved valuable additions. The total expenditure of the institute during the past year in all its departments has amounted to £30,429. 18s., not including the amount of £275 allocated to scholarships, leaving a balance for the year of £3,545. 16s. 7d., subject to allowance for depreciation on furniture, apparatus, books, etc.

Post Office Electrical Workers.—The *Morning Leader* is responsible for the following: "The workers in the electrical trades have a complaint against the Postal Department, and enter a protest against the methods of payment for their work and the system under which it is carried out. Strangely enough, one of their chief charges is that the method adopted leads to greatly increased cost—in some cases to as much as £3 per lamp compared with the average of £1. 10s. It was only recently that the workers and the taxpayers were congratulated on the fact that the installation at Mount Pleasant had been carried out directly by the Department instead of being given to a contractor; if the particulars given to our representative by the union officials are correct, there is not so much ground for congratulation as one might have hoped. In the first place, it is alleged that the Postal Department employ unskilled labour for a part of the work, and that this necessitates subdividing the work into three portions, a system which causes considerable loss of time. For the first portion of the work unskilled men are employed at what is called cutting the channels, while carpenters are employed at the casing; the unskilled men are then set to work to fit the wires in. In a private firm the whole of the work would be done by one set of men, all of whom would be skilled enough to undertake every part of the work, and to do it thoroughly. Then as to the wages, it is pointed out that the National Telephone Company pay their foremen 45s. and their leading hands 34s., the lowest rate paid being 24s. for the least skilled workmen. In the Postal Department the foreman is represented by the leading hand, who gets only 30s. for working under a Royal Engineer, who is in charge, and who receives 2½d. per hour for his service in keeping the civilian workman out of work. The lower grades of skill are paid for at 18s. to 22s. a week, while the rate at New Cross and other outlying parts are, it is alleged, even lower than that. Another complaint is that when men apply at St. Martin's-le-Grand for work they are asked, 'Do you belong to a trade union?' and if they answer 'Yes,' are not taken on unless urgently required, and are discharged at the earliest opportunity; the reason for this appears to be that the union rate for linemen is 9d. and for chargemen 10d. per hour, and the Department won't pay it, although they compel their contractors to do so."

The Telephone in Rural Districts.—Major-General C. E. Webber writes to the *Times* as follows: "May I occupy a few lines of your space in attempting to show that the telephone as well as the light railway may (in the words of the Queen's speech) be 'found beneficial to the rural districts'? In many countries the telegraph (including the telephone), which is the handmaid of railways, has been their pioneer, often because the capital outlay required for its establishment is comparatively small. As the future fate of the telephone service of this country is at the present hanging in the balance, it seems an opportune moment to

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draw attention to the question from the point of view of the 'continued seriously depressed condition of agriculture.' The county is the unit of area with which I have studied the subject, and the district round each market town is the natural site of an exchange system, with intercommunication between market and county towns. Some of the advantages of a complete telephone service to the dwellers in the rural districts of a county, through the establishment of a call office in nearly every parish, can be easily realised. To the farmers—the being able to converse with salesmen and customers at the market towns, saving journeys and avoidable movement of stock and produce. To the village tradespeople — the facility of promptly replenishing small stocks. To the inhabitants—the power to converse with the shopkeepers in the market towns for their larger purchases, thus keeping trade within the locality. To the dealers in perishable articles, such as milk and fruit, the value of the advantage is not easy to compute. The distribution of labour and material to meet demand would be better guided and expedited than existing means of communication admit of. Fire-engines and ambulance aid could be promptly summoned to places however remote, and, lastly, the administration of the executive duties of the county council would be enormously helped. I have worked out a scheme for such a rural telephone service in one of the purely agricultural counties, which has nearly 400,000 inhabitants and a gross rental of nearly two millions, and the figures present a very hopeful result. The material used would be what military telegraphers would call 'light permanent line' and of the character largely used in Europe for the telephone. Such a county would require 29 exchanges and call stations at 415 villages and hamlets. The length of pole line required to be erected would be a little over 1,000 miles, and the length of wire to be run a little over 4,000 miles. These figures are exclusive of the lines from private premises to the exchanges, which might in time be reasonably expected to number 700 or 800. The capital outlay would be about £49,000, and the annual cost, including interest, sinking fund, maintenance, renewal, working, and management, would be about £12,200 per annum. These figures are based on cost price as if the work was undertaken by the county council. To cover this a charge of 2d. would be made for each conversation of five minutes within arranged areas, and this must amount to a daily average of takings at each call office of 1s. 11d. The value of the service to the county administration and the net result of the revenue from the private lines would be profit. How far such a scheme would fit into the existing postal telegraph system, or interfere with or help it, is more a question for the Parliamentary Committee now sitting on the subject than for your pages. Without any delegation from them, I venture to advocate the cause of the local authorities in the 120 counties of the United Kingdom."

Electrolytic Reduction of Paranitrobenzoic Acid in Sulphuric Acid Solution.—Dr. A. A. Noyes, Ph.D., and Mr. A. A. Clements deal with this subject in a paper in the *Technology Quarterly* as follows : "In an article published some time ago, we showed that, when nitrobenzene in sulphuric acid solution is submitted to the action of electrolytic hydrogen, the resulting product is not aniline but the sulphonic acid of paramidophenol. That this reaction is characteristic of nitro compounds in general has since been proved by Gattermann, who investigated a great variety of them—nitro-hydrocarbons, nitro-anilines, and nitro-acids—and found them all to undergo change in a similar way, the reduction of the nitro group being accompanied by a migration of one of its oxygen atoms to the para position. Only those compounds in which the para position is already occupied by another element or group than hydrogen form exceptions to this rule. Of such compounds only two were investigated—paranitroorthotoluidine and paranitrotolulene. The reduction product of the former consisted of diamidocresol—CH_3 (1), NH_2 (2), NH_2 (4) OH (5)—a migration of an oxygen atom to the *ortho* position having taken place. In the second case there was obtained a complex body which was shown to result from the condensation of the primary reduction product, amidobenzyl alcohol, with a second molecule of nitrotoluene; thus, in this case, substitution of hydroxyl in the (methyl) group occupying the para position occurs. What reaction takes place seems, therefore, to depend on the nature of the para group, and the investigation of other para compounds in this direction is of considerable interest. We wish to describe here the reduction product of one of these, the paranitrobenzoic acid. We expected to obtain from it amidooxybenzoic acid, or possibly amidobenzoic acid itself; but, remarkably enough, neither of these substances is formed. The paranitrobenzoic acid used was prepared by boiling for one hour with return cooler portions of 20 grammes of paranitrotoluene with 60 grammes of potassium permanganate dissolved in two litres of water, filtering out the precipitate, concentrating the filtrate, and acidifying it. In this way 18 grammes—73 per cent. of the theoretical yield—were obtained. The apparatus used for the electrolysis consisted of a small beaker, to the sides of which a large platinum electrode was closely fitted, and in which was placed a porous cup containing sulphuric acid and a small platinum electrode to serve as the positive pole. The solution, made by dissolving 12 grammes of the nitrobenzoic acid in 100 grammes of warm concentrated sulphuric acid, was poured into the beaker, which was surrounded with asbestos to prevent loss of heat, and a current of one ampere passed through for 24 hours. To isolate the product the solution was diluted with water, cooled, and filtered. The precipitate was found to be very little soluble even in boiling water, showing the absence of sulphates of bases. It was treated with sodium carbonate solution, the residue consisting of sulphur was filtered out, and the filtrate was acidified. A voluminous precipitate separated; it was collected on a filter, and washed first with water, then with alcohol and ether to remove any unchanged nitrobenzoic acid. Four grammes of product were thus obtained. Its properties and analysis showed it to be paramidophenolsulphonic acid. It was only very slightly soluble in boiling water and insoluble in alcohol and ether. It reduced silver nitrate solution in the cold, with production of a purple colour. The solution of its salts turned brown rapidly in the air. It gave the following results on analysis :

	Found.	Calculated for $C_6H_3NH_2OHSO_3H$.
C	37·70	38·09
H	3·75	3·70
SO_3	42·40	42·33

To give further proof of the identity of the acid, some of it was heated to 175deg. in a closed tube with concentrated hydrochloric acid. At this temperature the sulphonic group was split off, as is the case with the paramidophenolsulphonic acid. The hydrochlorate, which crystallised out on cooling, was filtered off, dried, and boiled with a large excess of acetic anhydride. The resulting product, after crystallisation from water, showed a melting point of 152deg., identical with that of diacetylparamidophenol. The electrolytic reduction product of paranitrobenzoic acid is, therefore, paramidophenolsulphonic acid, the tendency of the oxygen atoms to assume the para position being great enough to expel the carboxyl group originally occupying it.

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LEICESTER ELECTRICITY WORKS.

This town is one of the most ancient in the annals of our history, and it is a happy augury to see an ancient historical town still striving to be amongst the very front rank of those whose municipal affairs are a pattern to their neighbours. Leicester was a prominent town before the Roman occupation; it became a Roman station of importance, nor did its influence lessen under the Saxons, whose name Legerecastre in a contracted form is the name of the town to-day. It is a busy hive of industry, with a world-wide reputation for its manufactures—principally hosiery, lace, and boots. It has enjoyed its municipal privileges since the time of King John, who gave its first charter, while succeeding sovereigns confirmed and extended the charter. During the recent revival of municipal activity Leicester has not remained idle, but has secured the control of the water and the gas supply, and, lastly, has entered into the great work of electric supply. We might also just mention that its sanitary work has been extensive, and carried out under engineers of the very first rank, such as the late Mr. Gordon and the present borough engineer, Mr. Mawbey. The development of the artificial lighting, as will be better understood later on, has been of recent years in the able hands of Mr. A. Colson, M.I.C.E., the borough gas engineer.

The engineer has had the full confidence of the Gas and Electric Lighting Committee, consisting of:

ALDERMAN LENNARD (CHAIRMAN).

MR. BILLINGS (VICE-CHAIRMAN).	MR. JENNINGS.
MR. BENNION.	MR. MAJOR.
MR. BOOTH.	MR. ORTON.
MR. BRUCE.	MR. PAYNE.
MR. J. T. CLARKE.	MR. POCHIN.
ALDERMAN COLEMAN.	MR. ROWLETT.
MR. COWLING.	MR. SMITH.
MR. EDWARDS.	MR. SPURWAY.
MR. FAIRE.	ALDERMAN WOOD.
MR. FLINT.	MR. H. H. WOOLLEY.

The Corporation of Leicester when they first contemplated supplying electric energy in their town determined that the whole of the work should be left in the hands of the borough engineer, Mr. Alfred Colson. His decision as to the system of supply and general type of plant was to be final, and it must be admitted from the following description that the confidence shown by the Corporation in their engineer was not misplaced. Mr. Colson was placed in charge of the gasworks at Leicester about 12 years ago, and has converted a marshy swamp often 3ft. under water into the site of one of the most complete gasworks in the kingdom.

The growth of the works under his care may be gathered from the money spent, which has in the time amounted to some £300,000, and better still from the plan, Fig. 1, which shows the extent of the works at the present time. As will be seen from it, the Corporation now possess the whole of the artificial lighting works necessary for satisfactorily and economically illuminating their town. At the gasworks there are most extensive coal stores, which should prevent the Corporation feeling any inconvenience in either the electric lighting or gas departments when unfortunate trade disputes arise in the coal industry. In the extensive chemical works the by-products of the gas production are carefully worked up into their most marketable state. The general appearance of the whole of the works is most pleasing to the engineering eye, and the library, in which the guests of the Corporation were entertained after the opening ceremony, shows the consideration shown to the employés. The library is well furnished with books and recreative games, and some 150 persons can be comfortably seated in the room.

Mr. Colson, having had a large general engineering experience, had the whole of the steam production and engineering details at his fingers' end, but he determined to make himself familiar with the electrical branches by undertaking the new work. So after seeing all the principal electric light stations in England, he travelled on the Continent with the same end in view. Mr. Colson's final decision was that in some points the foreign practice was likely to give less trouble in working, and also a longer-lived plant. The question of the speed and type of the engine was the special point in which he differed from most of the English contractors. They have been obliged by competition to cut down the first cost to its lowest limit, and, as also in many cases, the floor space as well. The result is that in the great majority of the electric light stations in England high-speed direct-coupled plants are used, and in others high-speed vertical engines with rope or belt gearing. With direct-coupled plants the cost of the electric generation also varies in the inverse proportion to the speed, and hence speeds below 200 revolutions are almost unknown except on shiplighting plants.

Taking the Cologne station as his general type, Mr. Colson determined to use the ordinary horizontal engine with Corliss valve gearing and to make the alternator take the place of the flywheel. Amongst the designs sent in to meet this requirement were some of the alternators since adopted and installed at Portsmouth, so that Mr. Colson may fairly be considered the moving spirit in the introduction of this class of machinery into English practice. So, as is often the case, we find again that the engineer to introduce a new type in an industry is one who approaches the requirements of that industry without prejudice and untrammelled by preconceived notions as to the way any operation must be done. The same individuality in design which we refer to above will be apparent to all our readers from the description and illustrations of the Leicester electric lighting station which follow. The whole of the design and outfit, even to the smallest detail, shows most careful personal attention on the part of Mr. Colson. The result is one of the best electric lighting plants in England, which from its position and outfit should enable the light to be supplied profitably at even less than 6d. per unit. The historical development of the work at Leicester is briefly as follows, and in it the engineer was very ably assisted by the members of his committee.

In August, 1889, the Town Council decided to apply for a provisional order for the supply of electricity, which was granted in the following year. In July, 1892, the Gas Committee, having also been appointed the Electric Lighting Committee, advertised for tenders, plans, and specifications for the supply of electricity. Although certain lines and conditions had necessarily to be laid down and conformed to, the contractors in the preparation of their schemes were allowed considerable latitude. Broadly, the invitation issued was for complete schemes and tenders, together with specifications and general drawings for the generation and distribution of current for a specified number of lamps assumed to be about evenly distributed throughout the "limited area"—that is, that portion of the borough bounded by Belvoir-street, Welford-place, Pocklington's-walk, Berridge-street, Grey Friars, Loseby-lane, Cart's-lane, High-street, Eastgates, Haymarket, Gallowtree-gate, and Granby-street—an area of 36,300 square yards, and comprising the centre and best business part of the town. The site for the generating station, the system of supply, the method of distribution, and kindred matters were left to the discretion of the competitors. They were to provide in their schemes and tenders for such reserve plant and apparatus as they deemed necessary. In preparing their plans and estimates the competitors were to bear in mind that, although the Corporation would go to no needless expense, on the other hand their object would not be to obtain the cheapest installation irrespective of its merits. The endeavour would be primarily to secure such an installation as would comply with the following conditions: (*a*) Perfect safety—*i.e.*, so far as science could render it, free from danger to life and property. (*b*) The generating station to be placed as to avoid every risk of nuisance or annoyance from vibration, etc. (*c*) The system to be thoroughly elastic—*i.e.*, capable of easy extension without extravagant outlay. (*d*) The method of distribution such as to necessitate as little interference as possible with the streets and roadways, not only when first laid down, but also in the case of renewals or deficient supply of current. (*e*) Every portion of the scheme and apparatus in connection therewith to be well beyond the experimental stage, of thoroughly approved efficiency, and to be of the very best description both as regards material and workmanship; the machinery to be

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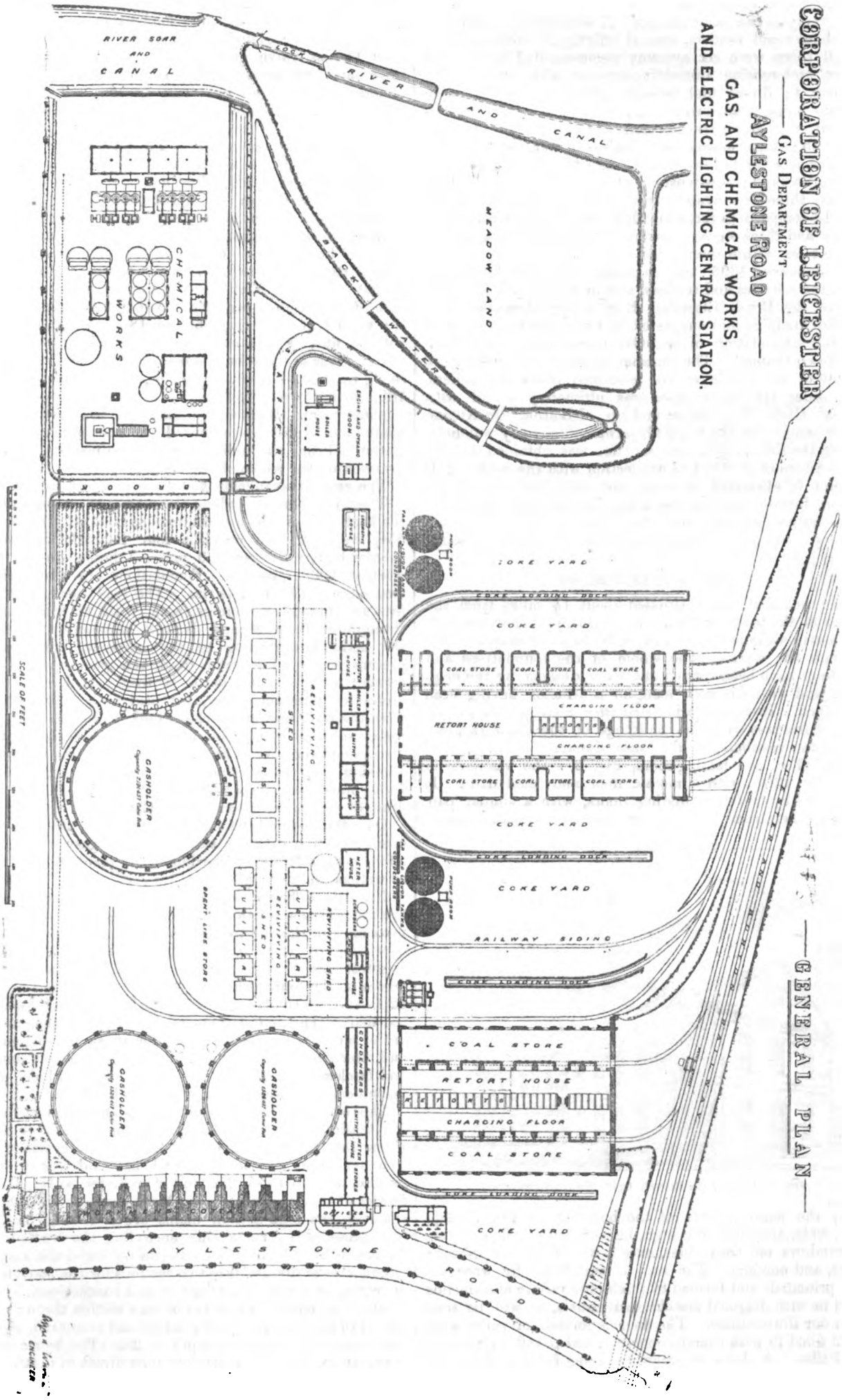

FIG. 1.—Plan of the Electric, Gas, and Chemical Works at Leicester.

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of such design as to reduce the wear and tear and risk of breakdown to a minimum.

In reply to the advertisement, 17 competitors submitted 25 schemes and tenders, several offering alternative plans. In all there were six systems recommended as follows: direct high-tension alternating-current, with house transformers, 4; direct high-tension alternating-current, with outside house transformers, 1; high-tension alternating-current, with street transformers and low-tension distribution, 15; high-tension continuous-current, with street transformers and low-tension distribution, assisted by accumulators, 2; low-tension, with accumulators, 2; low-tension three-wire system, with accumulators, 1. As to site, 14 competitors recommended the Aylestone-road Gasworks, and three were in favour of the works being placed in the town within the limited area.

In January, 1893, the engineer submitted his report upon the schemes and tenders, and in the following month that of the Brush Electrical Engineering Company, with certain modifications suggested by the engineer, was, upon the recommendation of the Gas Committee, accepted by the Town Council. The contract entered into was for the supply of the whole of the electrical plant and boilers. The order for the engines was ultimately placed with Messrs. Hicks, Hargreaves, and Co., of Bolton. In August of the same year the usual Government enquiry was held, and in the following month sanction was obtained for the expenditure of £42,574 in connection with the work. This amount is estimated to cover, not only the cost of the present installation, but also a further extension of cables. The system adopted was the high-tension alternating-current, with street transformers and low-tension distribution.

The Central Station.

The central station is situated about 1½ miles from the centre of the town, at the gasworks on the Aylestone-road. It stands on the left-hand side of the main avenue running through the works. The whole of the foundations and buildings have been carried out from designs by the engineer, and with his own men, no contractor having been employed. It is a red-brick structure, corresponding in its general features with the buildings of the gasworks, and comprises vestibule, engine and dynamo room, boiler-house, office, and testing-room, Fig. 2. The vestibule is 18ft. by 13ft., with a mosaic floor and tiled dado. It is entered by half-glass folding doors, with a similar pair leading therefrom into the engine and dynamo room.

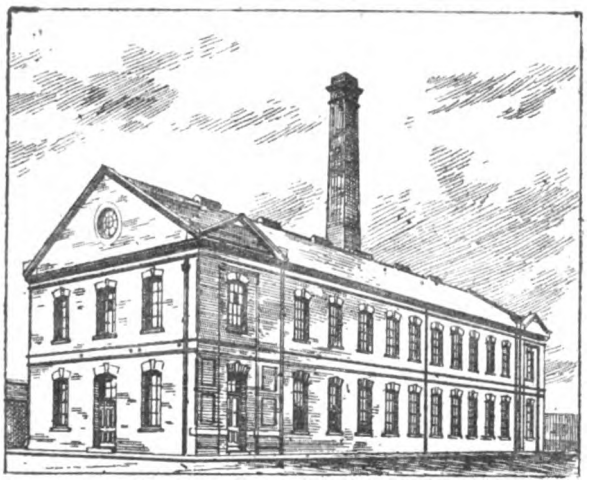

FIG. 2.—View of the Electric Light Works at Leicester.

This, the main feature of the building, is 114ft. long, 40ft. wide, and 31ft. 6in. high, lighted with a double tier of windows on both sides, except where the boiler-house abuts, and one end. The roof is supported by wrought-iron principals and formed of pitch-pine rafters and purlins filled in with diagonal matchboard panels, as will be seen from our illustrations. The floor is formed of rolled-steel joists filled in with cement concrete, and paved with tessellated tiles. A dado encircles the room formed of matchboarding, with moulded cap and skirting, the whole being stained and varnished to correspond with the roof. The generating plant consists of three Mordey-Victoria alternators, each of 200 kilowatts capacity, coupled direct to three horizontal compound condensing engines, each of 350 i.h.p. Both cylinders are steam jacketed and fitted with Corliss valve gear. The governors are unusually large and powerful, and control the gear on both cylinders. The engines run at 96 revolutions per minute. Each engine is provided with a jet condenser and an air-pump worked by a rocking beam attached to the low-pressure piston rod. In addition to the large alternators, there is also a small machine intended for the light or day load. This has a capacity of 75 kilowatts, and is driven by a 135 i.h.p. engine of similar construction to the larger engines, except that Corliss valve gear is not provided for the high-pressure cylinder and the high-pressure cylinder only is governed. This engine runs at 120 revolutions per minute. The exciters consist of two Victoria continuous-current dynamos, each of 13 kilowatts capacity. Adjoining the engine-room is a workshop measuring 26ft. by 18ft. When finished it will be fitted with a complete set of machine and other tools. Over the vestibule and shop is an office and testing-room, reached by a spiral staircase, and measuring 41ft. by 18ft., with a roof corresponding to that of the engine and dynamo room. Here will be fixed all the testing instruments and apparatus required in connection with the station. From this office access is gained to a balcony overlooking the whole of the machinery.

The general arrangement of plant is shown in Fig. 3.

The boiler-house stands at the rear of the main building, the back wall of which is common to the two. It measures 55ft. by 42ft., and contains four Babcock and Wilcox tubular boilers, each of 250 nominal horse-power. These work at 120lb. pressure. Foundations are already in for two more boilers of like size. The feed water is supplied by two three-throw pumps, each with engine attached, through a Babcock and Wilcox economiser, placed in the main flue leading to the chimney. The fuel at present employed is coke from the gasworks. In one corner of the boiler-house is fixed an Evans duplex pump for pumping water, for feed and other purposes, from the river into an overhead tank placed in the adjoining chemical works. The water for condensing is taken direct from the river, the difference in levels fortunately allowing this to be done. The three openings into the boiler-house are protected by revolving shutters. The draught is obtained from a stack 125ft. high.

On either side of the station are railway lines in direct communication with the sidings at the gasworks. These afford great facilities for the delivery of plant and apparatus, as well as fuel for the boilers.

No little difficulty was experienced in connection with the foundations for this work. This arose from the close proximity of the site to the River Soar and to the subsoil consisting of peat, running sand, or silt. To avoid the slightest risk of settlement in any part of the work, the whole of the foundations were carried down to a depth of 22ft.—viz., to the Keuper bed, which consists of good hard red marl. The foundations of the walls of the building are of blue lias lime concrete, while those for the engines and alternators are composed of Portland cement concrete and brickwork in cement. The beds for the whole of the machinery are formed of best Derbyshire stone.

The whole of the distribution systems, both high and low tension, consists of Fowler-Waring concentric cables. From the central station, Fig. 4, two high-tension cables, iron armoured and lead covered, are laid naked in the ground at a depth of 2ft., and run direct to No. 1 transformer-chamber situated in Market-street. From this chamber the high-tension mains are drawn in 3in. cast-iron pipes, and form a ring encircling the limited area. By means of switches placed at two points in this ring, the circuit can be divided into two sections for the convenience of testing and making alterations and connections.

The low-tension mains are of one section throughout—viz., ·146 square inch—lead covered and armoured, and laid naked in the ground at a depth of 2ft. The house service connections, also concentric, are teed direct to these, a lead joint being wiped on to ensure the lead covering remaining intact, the whole being armoured by a cast-iron tee clamp.

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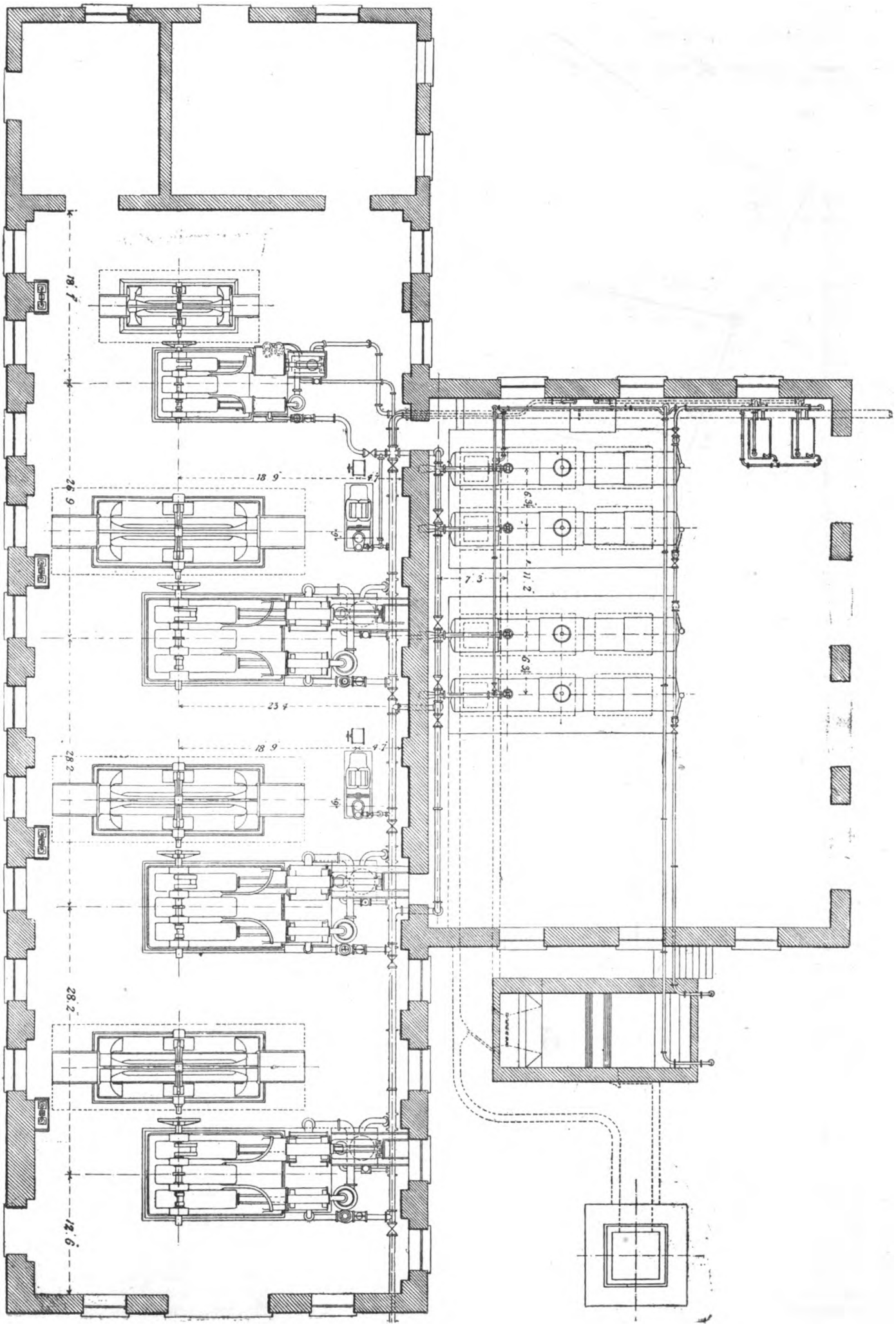

Fig. 8.—General Arrangement of Plant at the Leicester Electricity Works.

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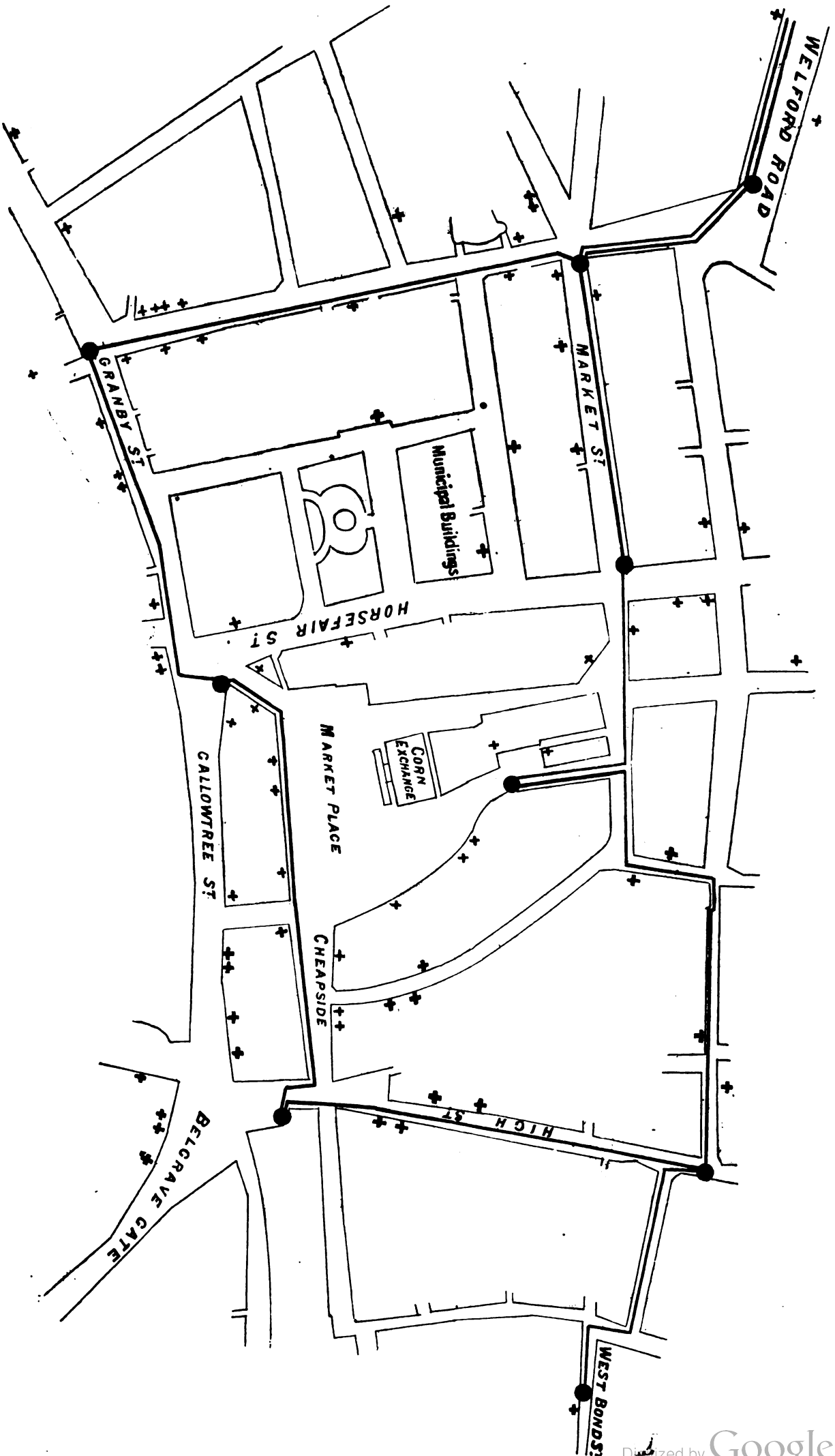

FIG. 4.—Plan of Mains at Leicester. — High-Tension Mains. • Transformer Chambers. + Consumers Connected up to April 25, 1895.

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The transformer chambers are eight in number, their internal measurement being 7ft. 6in. long, 5ft. 6in. wide, and 7ft. high. The sides and ends are cambered, having a rise of 6in. The walls of the chambers are formed of good hard bricks in cement in two thicknesses, with an inch space between. This space is filled in with specially prepared asphalte, which is also continued under the paving of the floor as well as over the roof, thus making the chamber perfectly water and gas tight. The roof is formed of rolled-steel joists filled in between with cement concrete. A suitable manhole with double cover is provided for access to the chambers, which are descended by means of step-irons built into the inner thickness of wall. All the chambers have an air inlet and outlet for securing proper ventilation. The bellmouths of the pipes carrying the high-tension mains are caulked with Vulcan cement, with the object of preventing any gas finding its way into the chambers. As an additional precaution against this occurring, the pipes are provided with a ½in. hole about 1ft. from the back of the wall of the chamber, which communicates with a ventilating flue. This arrangement allows any gas which finds its way into the pipes escaping before reaching the chamber. A similar arrangement with the same object is provided in connection with the low-tension cables.

Although the official inauguration of the works is only taking place this week, the light was first supplied to the town on December 19 last. At present no cables are laid beyond the limited area, but recently the Gas Committee decided to carry these through Stoneygate—the residential quarter—for a distance of something like two miles. The total number of meters fixed is 91, and lamps wired equal to 6,000 8-c.p. The price at present charged is 6d. per unit. In connection with this work has been organised an electric light fitting department, which has carried out about four-fifths of the total installation work in Leicester. The profit from this goes towards reducing the loss at present incurred in supplying the light. A suitable showroom at the gas offices is well stocked with the best of everything obtainable in the way of fittings.

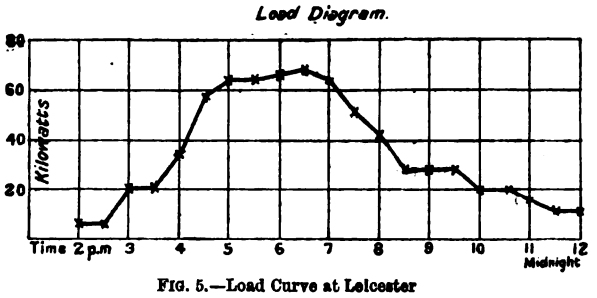

FIG. 5.—Load Curve at Leicester

The present demand for lighting is satisfactory when it is considered that the supply was only commenced at the end of December. The curve which we give, Fig. 5, was taken on January 8, 1895, and shows a maximum load of 78 kilowatts and a total output of 360 Board of Trade units for the day. Judging from the population and the number of high-class streets in Leicester, we believe that this load will rapidly increase till the full capacity of the station is exceeded.

Owing to the large number of special features needing description in the machinery of the station, we are compelled to hold the detailed descriptions over till our next issue.

The formal ceremony of opening this installation took place yesterday, when Councillor BILLINGS, on behalf of the Corporation, congratulated the committee upon the success of its efforts during the last six years. He especially congratulated both the chairman and the engineer upon the successful completion of their arduous labours. He pointed out that Alderman Lennard had during the six years directed the deliberations of the committee, and that they had spared no pains in collecting all the information they could upon the subject; while their engineer, Mr. A. Colson, had visited almost all the English and continental stations, and after carefully examining them, selected what he thought to be the best system. Now they had the electric light at work in such a manner that the safety of life was assured so far as humanity could practically assure it, while thorough efficiency and durability had been aimed at throughout the design.

Alderman LENNARD then gave the company a hearty welcome, and entered into an explanation of the works at which they were assembled. He alluded in the first place to Faraday's experiments, and pointed out that these formed the germs of the present magnificent apparatus which were there installed. They had before them engine room to the extent of something like 1,185 i.h.p., capable of supplying over 11,000 16-c.p. lamps; allowing one machine to be kept in reserve, they could supply 8,000 such lamps. The position of the station was very suitable, for they had an ample supply of water and ample room for coal storage. The foundations of the building presented some difficulties, seeing they were about 22ft. below the floor level, but their engineer had made them perfectly satisfactory. It was Mr. Colson who had designed the first direct-coupled flywheel alternator, which was shown in the gas office some three years ago. Although another corporation had started similar plans previously, he (their engineer) certainly originated the type in England. He then asked the visitors to walk round the station, and called upon Mrs. Lennard to start the engines.

Mrs. LENNARD, who formed the centre of a picturesque group, then successfully started the engines amidst much applause, after which the company adjourned to luncheon.

The luncheon was served in the library at the works, at which Mr. Lennard presided, there being about 130 guests present.

After the CHAIRMAN had proposed the toast of "The Queen," Mr. J. F. ROLLESTON, J.P., proposed "The Corporation." He spoke, as a past member of the Corporation, of the business capacity of the Council as shown by their flood, drainage, gas, and chemical works. In spite of the liberal improvements which had been carried out, the rates were on a down grade. He congratulated the Gas Committee upon making friends with the rival illuminant, the electric light, and taking it into partnership.

The MAYOR responded, enumerating the good work done by the different committees.

Mr. J. S. RAWORTH proposed "The Gas Committee and Success to the Electric Lighting Undertaking" in a humorous speech, in which he referred to the nuptials of the two rivals, much amusement being caused by the band striking up "The Wedding March." He alluded to the business capacity of the committee and the great engineering skill of Mr. Colson, who was the active designer of the whole station.

Alderman LENNARD responded on behalf of the committee and himself. He remarked that they had spent only £33,000 out of £42,000 which were borrowed. They were thus in the position of being the only town which had not exceeded the original estimated cost. Lamps to the extent of 3,000 16 c.p. were now fixed, and he was confident that they would pay their expenses this year.

Sir THOMAS WRIGHT proposed the toast of "Trade and Commerce," to which Sir COURTENAY BOYLE, K.C.B., responded in an able speech.

Alderman E. WOOD proposed the last toast, that of "The Contractors," to which Mr. HUDSON replied on behalf of Messrs. Hicks, Hargreaves, and Co., and Mr. COLSON on behalf of the Corporation officials.

CITY AND GUILDS OF LONDON INSTITUTE.

SOLUTIONS TO THE NUMERICAL QUESTIONS IN ELECTRIC LIGHTING AND POWER TRANSMISSION.

ORDINARY EXAMINATION, 1894.

2. A straight wire carrying a continuous current of 500 amperes lies at right angles to the magnetic flux in a field the intensity of which is 10,000 lines per square centimetre. State the force in pounds per foot of the wire tending to produce lateral displacement.

Solution 2.—The mechanical force experienced by a conductor carrying a current in a direction at right angles to

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the lines of force of the magnetic field in which it is placed is proportional to the strength of the current, to the intensity of the magnetic field, and to the length of the conductor; or, algebraically,

$$F \text{ (dynes)} = H \times C \times l,$$

where H = number of lines per square centimetre;
C = current strength in absolute units;
l = length in centimetres.

If C be given in amperes, then

$$F \text{ (dynes)} = H \times C \times l/10.$$

In the example l is 1ft., and this equals 12 × 2·54cm., since 1in. = 2·54cm. Therefore substituting the values given, we get

F = 10,000 × 500 × 12 × 2·54/10 dynes per foot length;
= 15,240,000 dynes;
$= \frac{15,240,000}{981}$ grammes weight. Since one gramme weight = 981 dynes,
$= \frac{15,240,000}{981 \times 453·6}$ pounds weight. Since one pound = 453·6 grammes,
= 34·25 pounds weight.

Answer.—34·25 pounds.

Note.—The above solution is by the method of "first principles," and is useful as an example of changing from absolute units to other systems of units. The general formula is—

$$F = k \,.\, H \times C \times l,$$

where k is a constant depending on the system of units used. In the above example F is required in pounds, and l is given as 12in., in which case $k = 57 \times 10^{-8}$; whilst C is in amperes, and H in C.G.S. units. Substituting these values—

$$F \text{ (pounds)} = 57 \times 10^{-8} \times 10,000 \times 500 \times 12 = 34·2 \text{ pounds.}$$

6. Current is required along a street 2,000ft. long at the rate of one ampere per 10ft. of frontage. Give sectional area of conductor so that the difference of pressure between any two lamps shall not exceed two volts in the following two cases:

(a) The current being supplied at one end;

(b) The current being supplied midway.

[N.B.—The resistance of a copper bar 1,000ft. long and one square inch in cross-section may be taken at ·008 ohm.]

Solution 6.—(*a*) Assuming a lamp to be placed between the mains at intervals of 10ft., there will be 2,000/10 or 200 lamps; and if each requires one ampere, then 200 amperes will be required. Let R be the resistance between two lamps, then 200 × R = 2, or R = 1/100 ohm = resistance of 10ft. Now, the resistance of a copper bar 10ft. long and one square inch in cross-section is $\frac{1}{100}$ of ·008 ohm, or ·00008 ohm. Therefore, if A is the required area of cross-section, then

1/100 ohm : ·00008 ohm :: one square inch : A square inch.

$$\therefore A = \frac{·00008}{1/100} = ·008 \text{ square inch.}$$

(*b*) When the current is supplied midway the mains will be required to convey only 100 amperes, so that

100 × R = 2, or R = 1/50 ohm = resistance of 10ft.

As in (*a*),

1/50 ohm : ·00008 ohm :: one square inch : A square inch;

$$\therefore A = \frac{·00008}{1/50} = ·004 \text{ square inch.}$$

7. Explain numerically the relations between the dyne, the erg, the joule, the kilogramme, the British horse-power, and the metric (French) horse-power.

Solution 7.—The *dyne* is the C.G.S. unit of force, and is such that it produces an acceleration of one centimetre per second when acting on a mass of one gramme for one second. The *erg* is the C.G.S. unit of work, and is the work done in overcoming a force of one dyne through a distance of one centimetre. Thus the erg is one dyne-centimetre. The *joule* is the practical unit of work, and is 10,000,000 or 10^7 times as great as the erg. Thus one joule = 10^7 ergs. The *kilogramme* is 1,000 grammes, and the gramme is the C.G.S. unit of mass, and is the mass of a cubic centimetre of distilled water at 4deg. C. Now, gravity imparts to a mass of one gramme an acceleration of 981 centimetres per second, and the force with which the earth attracts any mass is termed the *weight* of that mass, so that the weight of one gramme is equivalent to a force of 981 dynes. Consequently, the weight of one kilogramme equals 981,000 dynes. *The British horse-power* is the practical (British) unit of power, and power is the rate of doing work. The absolute unit of power is one erg per second, whilst 10,000,000 ergs per second is the practical unit of power in the C.G.S. system, and is termed the *watt*. One horse-power is 746 watts (approximately), or 7,459,571,687 ergs per second. *The metric* (*French*) *horse-power* is 735·75 watts, or 7,357,500,000 ergs.

9. A Gramme armature, intended for a two-pole field, has 120 turns of conductor wound upon it. Give the total flux required through armature core if an E.M.F. of 100 volts is to be induced at a speed of 1,000 revolutions per minute.

Solution 9.—The E.M.F. induced in an armature rotating in a two-pole field is given by the following formula:

$$E = M_F \times T_{aw} \times n / 10^8,$$

where E is given in volts;
M_F is the magnetic flux;
T_{aw} is the number of turns on the armature;
n is the revolutions per second.

Substituting the given values:

$$100 = M_F \times 120 \times \frac{1,000}{60} \times \frac{1}{10^8};$$

$$\therefore M_F = \frac{100 \times 60 \times 10^8}{120 \times 1,000} = 5,000,000 \text{ lines.}$$

Answer.—5,000,000.

10. Calculate the number of ampere-turns of excitation required to magnetise, up to 14,000 lines per square centimetre, a soft iron ring, 20in. in mean diameter, made of round iron 1in. thick. (Assume permeability = 800).

Solution 10.—The lines of induction induced in an iron ring on which is wound wire through which a current is passed is given by the following formula:

$$B = \frac{·4 \pi C n \mu}{l} \text{ C.G.S. units,}$$

where B is the flux per square centimetre;
μ is the permeability;
l is the length of the helix of wire;
C n is the number of ampere-turns.

Since 1in. = 2·54cm., $l = 20 \times 2·54 \times \pi$ centimetres. Then by substituting the given values we get—

$$B = \frac{·4 \pi \,.\, C n \,.\, 800}{20 \times 2·54 \times \pi} = 14,000,$$

$$\therefore C n = \frac{14,000 \times 20 \times 2·54}{·4 \times 800} = 2,222·5.$$

Answer.—2,222·5.

ALTERNATING AND INTERRUPTED ELECTRIC CURRENTS.*

BY PROF. GEORGE FORBES, M.A., F.R.S., M.I.C.E.

When I was asked by Sir Frederick Bramwell to give a short course of lectures here, I asked him what subject he would like

* Lecture delivered before the Royal Institution.

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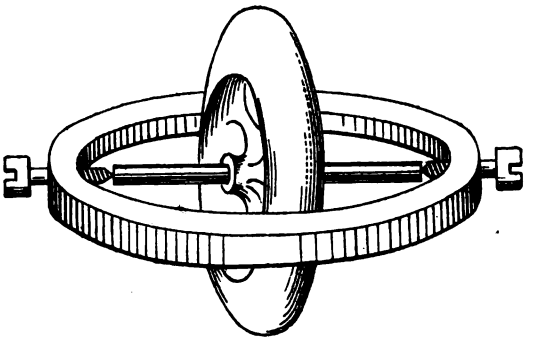
me to lecture on, and he said, "Some physical subject." I am aware that at the Royal Institution it is generally the custom to deal with principles rather than applications of science, consequently I thought over what might be the best subject to discourse on. It happened that in the course of the work upon which I have been engaged during the last few years I have had occasion to try and find some simple means of expression to convey to my own mind, and also to the minds of others, certain somewhat obscure electrical phenomena which take place especially when using alternating or interrupted currents, and I arrived at a method of producing mechanical analogies to the various cases of the propagation of electricity which was of such very great assistance to myself, and which enabled me so much easier to convey some intelligent idea of these curious electrical actions to others, that I thought it might be well to incorporate them in the present lecture.

Prof. Dewar told me yesterday that you would be expecting me to talk about the Niagara Falls, and that you would be disappointed if I did not. I can only say that I cannot imagine why any such opinions should have been held, and I can only express regret if I am disappointing those present by taking up a different subject. However, I have this to say, that while the present lecture does deal with some of the work which has been going on there, it deals far more directly with submarine telegraphy. The next two will deal almost entirely with problems which have been cropping up in the work of utilising those great falls and distributing the power in the neighbourhood, so that I trust it will not be altogether a disappointment to those who had expected a different course.

Before beginning my subject I have also to say that I have a good many experiments to show you to-day, and in the following lectures, which I do not wish you to think for one moment are original—some are somewhat striking, but they have been evolved after very patient work by others than myself. I particularly mention the name of Mr. Campbell Swinton, who has placed at my disposal some extremely beautiful apparatus which I shall have frequent occasion to refer to. Others have assisted me much. Dr. Muirhead has been invaluable to me in the assistance he has given me in illustrating the present lecture by enabling me to produce before you some of the phenomena which are produced in submarine cables. This is a subject which has hitherto been wrapped up in a certain amount of obscurity—of mathematical symbols; and while dealing with that it is my hope that I may be able to divest the treatment of the subject of those difficulties, and make the phenomena which appear in submarine cables generally intelligible to anyone.

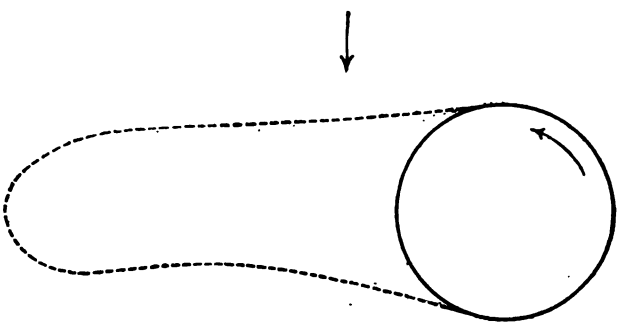
When we speak about the propagation of electric currents through an Atlantic cable, we know that while the electricity is passing into the cable a charge of electricity is being imparted to the outside of it, the cable is being charged, and that prevents the rapid propagation of the current through it. Now, it is all very well to talk about it in that sort of language, but it is not very intelligible, and for this reason, that it is difficult to understand. We do not understand exactly what we mean by electricity. All the time we are using such a phrase, we are trying to grasp some mechanical analogy which shall make it intelligible to us. For instance, in dealing with the propagation of electricity, it has been very common in the past to treat of electricity by the analogy of a flow of water through pipes, and an excellent analogy it is. The pressure of the water is the E.M.F., which compels the water to move, the velocity of the water acquired in the pipe is the current, and the friction of the pipe represents the resistance of the wire. If you have a pipe in a complete circle, with a centrifugal pump at one part and the whole of the power being used in the friction of the pipe, you have there the analogue of a battery with a certain pressure, of a closed circuit carrying a current, with a certain amount of resistance; and the velocity of the water increases and increases until the backward force caused by the friction of the pipe is equal to the motive force, or the pressure of the water, in the centrifugal pump. That is the ordinary analogy employed for the most ordinary phenomena. We might extend that analogy, and instead of using up the whole of the energy of the centrifugal pump in the friction of the pipe, which is equivalent to heating the conductor, we might place a very narrow bit of pipe at one end of it. The energy would then be almost entirely consumed in that narrow pipe at the far end. Now, that is analogous to the light in this room. The centrifugal pump is the dynamo in the central station, the wires that go round are the wires that go to and from the central station, the narrow bit of pipe at the far end where the power is used up is the analogue of the incandescent lamp. Instead of placing that small pipe at the end, we might have a little water motor, like a turbine, and we should then have a central pump, a limited amount of whose power is used up in friction in the pipe, and at the end the motor, which might be doing useful work. There we have the power in a central station, in which the centrifugal pump represents the dynamo, the pipe represents the wires along which a current is flowing with a certain amount of resistance, and the turbine at the far end represents the electric motor which is driving the machinery. That is a very useful and simple sort of analogy, but when we come to some more obscure points this analogy fails to be quite so easily understood, though in many cases it is a very good one indeed. I am speaking about the difference between ordinary cases which are easily understood, and cases which are somewhat more obscure. In the ordinary ways of electric lighting in a house or from a central station the method of the propagation of electricity is comparatively simple, and any person who has played with a battery and wires is able to see at a glance what will happen when you connect the wires to the dynamo and then to the lamp. But there are other phenomena which come in later, especially when using alternating currents, which are not so easily understood. As I am going to adopt mechanical analogies to show the electrical phenomena, I may well here adopt a mechanical analogy to show you the different class of phenomena which I wish to illustrate. There are many mechanical phenomena which are perfectly obvious to any intelligent person when looking at them. If you have a steelyard with a heavy weight supported at the short arm and a light weight at the long arm, it is perfectly natural that the heavy weight may be supported by the light weight without going into the mathematics of it or measuring the quantities and proportions—the result is a very obvious one to every person. When I exert pressure upon a screw press, I with a very little pressure and a large motion of my hand produce a very small downward motion, but a huge pressure upon a copying book, for instance: that is a transformation of mechanical energy which is perfectly obvious. And so with the different mechanical powers—the lever, the wheel, and axle working a crane—any of these are perfectly obvious.

I will now show you one or two not quite so obvious phenomena, and the first which will occur to everyone of you here is simply the gyrostat, which everyone of you know, but



which I wish to show you because it illustrates what I am working at. [*Experiment.*] All I wish to say with respect to the gyrostat is that it takes a little time and a little thought to realise why it is that the wheel does not twist in the direction in which the obvious forces are impelling it. That is a thing which requires a considerable amount of thought before you arrive at a correct conclusion. Why does it twist round, and in which direction does it twist? These are things which are not perfectly obvious, and which do require a very considerable amount of thought to make them clear. If I were able to show you a mechanical analogy which would make that clear, it would be a great step. And in the case of the electrical phenomena I think I shall be able to show you some analogies which are equally good.

Here I have a chain caused to revolve by means of an electric motor, and the motions which take place are those which are not perfectly obvious to the very well-trained mechanic.



[*Experiment.*] When I draw this chain towards me it acts somewhat like a rigid bar. If I impress a motion on it it retains that motion; and if I draw the chain out for a considerable distance and let it go, it goes through a series of motions which are somewhat difficult to understand, which you would not have foreseen if you had been asked to say what was the action.

(To be continued.)

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MUNICIPAL ELECTRICAL ENGINEERS.

What to do with mothers' sons is becoming a more and more important problem every day in the households of the United Kingdom. A profession that has few prizes and many blanks, especially when the prizes themselves have no very great attraction, does not attract the best men. It may be that it contains openings for hundreds, if not thousands, of units, but few of these units come into prominence because of talent. The electrical engineering profession is such an one. It employs many men, most of whom are mere items, and will remain items to the end. These items are intensely ignorant of the why and wherefore of their everyday work. Their only view is bounded by the wall of as much pay as possible and as little work as possible. Their ignorance compels them to wait for assistance at the rise of every little difficulty. We should prefer to see more men ready to grapple with the difficulty and capable of stepping into a higher position when the chance offers. When the standard of knowledge in any profession is of a high order, wages and salaries also average higher in amount, because the universal law of supply and demand acts in this direction. The most recent development in the electrical industry seems to warrant the conclusion that in future the number of prizes will be greater, and this will lead to greater competition for such prizes, and inevitably to a higher standard of knowledge in certain ranks of the profession. Hitherto, putting aside the question of consulting engineers, with which we are not now dealing, the best positions open to general competition have been those of municipal electrical engineers. The remuneration, except in a few cases, has, however, been too low, but this may probably have arisen from the youth of the profession. No one in the earliest days could adequately grasp the value of the work to be done, and municipalities were cautious in offering too much. As time went on, it became clear that to successfully manage a central station demanded capacities of a much higher order than were originally thought necessary. In more than one case success has been taken as obtained automatically, but the illness or departure of the successful organiser has opened the eyes of those who controlled the management. It is an open secret that some companies have found the loss of a man of far greater importance than they ever suspected. We, however, have no intention of dilating further upon the settled conviction of business men, that the proper course to pursue is to employ those who know their business, and to pay them well for their work. Experience is only gained by age, and experience is worth paying for. To return to the object of this article—a reference to the step taken by the St. Pancras Vestry. From the advertisement it will be gathered that this Vestry look upon their electrical engineer somewhat in the same light as they do their ordinary engineer, and are desirous of placing the two in a measure upon a similar footing. Perhaps, however, a better analogue would be that of a gas engineer to a local authority. The gas engineer is expected to organise, manage, design, and carry out

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the ordinary work of extensions. Now, whatever the attainments necessary to successfully manage a central electric light station, other special attainments are required if the manager is to act as engineer also—to design, specify, and superintend new work. That we can obtain men having the requisite attainments for both classes of work is undoubted. Is the salary offered sufficient to induce the men of higher calibre to enter the profession? Considering that few such positions are yet open to competition, we think that the St. Pancras authorities are making a fair offer, and a commencing salary of six hundred pounds a year will probably lead to an able man rising to one thousand pounds a year. The latter figure will not be found in any accounts for some years to come, but it is evidently within the bounds of practical electric lighting politics. If central-station work increases and is successful, as it seems likely to be in the hands of the authorities, we shall certainly see in not a few instances an expenditure of a million pounds or so for the complete lighting of a large city. The electrical engineer will then have a most responsible position in the earning sufficient revenue to pay interest and repay loan account, and ought to be adequately remunerated. The amount one thousand pounds is none too large for this responsibility, but is good enough to obtain the best men. We trust that those already in the profession will give due attention to these facts, and endeavour to gain the experience necessary to satisfactorily fill these positions.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

NOVEL APPLICATIONS OF ELECTRICITY.

SIR,—The other day a friend of mine who is a jeweller asked me jokingly whether I could rig up an electric shock-producing device for testing diamonds and the detection of sham or paste diamonds. After thinking the matter over, I presented him, a couple of weeks later, with the following apparatus to his entire satisfaction: To the spindle of a small electric motor is attached a small thin disc made of aluminium and placed in horizontal position. A clamp with a small flat spring, and provided with an adjustable screw, holds fast a ring or any other article with the real or sham "brilliant." The ring, etc., is moistened, and slowly moved by hand towards the disc, driven at a high speed by the motor, thus applying, so to speak, a brake to the motion of the disc. The idea is based on the fact that if a sharp piece of aluminium be rubbed on moistened glass, brilliant metallic markings result on the glass diamonds, but not on those which are genuine. If some metallic marks are found on the so-called "diamond," then, of course, it is not a genuine article; otherwise it is a real diamond of the first water.

I am not a philatelist, but by some chance I became a possessor of a few hundreds of good genuine stamps. As I am of original mind, I did not gum them into the usual old-fashioned stamp album, but I rigged up a special apparatus for the purpose: An endless thin leather band is driven by means of an electric motor at a very low speed. The stamps were pasted to the band, and this combination was fixed inside a longitudinal box, ornamented externally with velvet and fancy brass nails and rosettes. At a certain part of the box is fixed a small movable brass tube provided with an objective glass. A small electric incandescent lamp, provided with a silvered reflector, is also fixed inside the box. By pressing on the pear-shaped button every stamp is seen magnified many times its size, is succeeded soon by another stamp, and at the same time more "light is thrown on the subject."

The last novelty is an electric egg-testing device, and consists of a box ornamented by velvet, rosettes, etc., and provided with two holes. In a corner inside the box is fixed a mirror at 45deg. A small electric lamp is fixed outside the box in such a manner that it throws light on the egg placed in the hole in the top of the box. Through another hole or aperture you can see through reflection on mirror whether the egg is translucent or not. Of course, the idea is based on the well-known fact that if you hold a bad egg opposite strong light of a lamp, etc., you can see black stains or streaks inside it. A good egg is translucent or partly transparent.

Though my above little inventions are not of much practical value, there are, I believe, a few readers of the *Electrical Engineer* who would try novel original ideas.

I may add that the simplest and best method to demonstrate the well-known Newton's law—viz., that white is a mixture of all known colours—consists in fixing a small paper disc with many coloured segments on it to a spindle of a small electric motor. During the quick rotation of the disc you see a perfectly white disc, which proves Newton's theory. If on the disc are drawn thick black lines and segments in a certain manner, and if opposite close to the said disc a small electric lamp provided with a reflector is placed, and you look at the rotating disc, a very queer phenomenon takes place—viz., if the disc is rotated in one direction you see red lines, if in another direction you see yellow or blue lines. In this manner you can produce an artificial rainbow out of white and black. The reversion of the motor could be made by a suitable commutator as used for the Ruhmkorff induction coil.—Yours, etc.,

R. W. HILL.

Manchester.

WHAT, WHEN, AND WHERE.

Royal Institution, Albemarle-street, Piccadilly, W.

April 26, 9 p.m.—"The Effects of Electric Currents in Iron on its Magnetism," by Dr. J. Hopkinson.

April 30, 3 p.m.—The second of a course of three lectures on "Alternating and Interrupted Electric Currents," by Prof. George Forbes, M.A., F.R.S., M.I.C.E.

Institution of Civil Engineers.

May 2, 8 p.m.—Special meeting in the Theatre of the Royal United Service Institution, Whitehall. The third "James Forrest" lecture—"The Development of the Experimental Study of Heat Motors."

Institution of Electrical Engineers.

May 3, 8 p.m.—Students' meeting in the Library of the Institution. "Single-Phase Alternate-Current Motors," by A. S. Eborall.

Sanitary Institute, Parkes Museum, Margaret street, Regent-street, W.

April 26, 8 p.m.—"Scavenging Disposal of House Refuse," by H. P. Boulnois, M.I.C.E.

April 27, 2.15 p.m.—Inspection and Demonstration of the Sewage and Destructor Works at Ealing, conducted by Charles Jones, M.I.C.E.

Society of Arts, John-street, Adelphi, Strand.

April 29, 8 p.m.—Cantor Lecture by James Douglas on "The Recent Metallurgy of Copper, Lead, Gold, and Silver in America." Lecture II.

May 1, 8 p.m.—Nineteenth ordinary meeting. "Deviations of the Compass," by Prof. A. W. Reinold, F.R.S.

Physical Society.

April 26, 5 p.m.—At the Physical Science Schools: 1. "A Theory of the Synchronous Motor," by W. G. Rhodwell. 2. "Note on a Simple Graphic Interpretation of the Determinantal Relation of Dynamics," by G. H. Bryan.

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A REMARKABLE ELECTROLYTIC PHENOMENON.*

Most metals, when used as positive electrodes in electrolysis, are either dissolved or corroded, producing metallic salts or oxides; but when used as negative electrodes, metals do not generally undergo such corrosion. They are seldom affected in any way, chemically, by the action of the current, and are never dissolved. It is to what appears to be an exception to this rule that I wish to call attention.

While experimenting some time ago on the oxidising effect of various electrolytes upon lead electrodes, I noticed, accidently, that under certain circumstances lead behaves toward some electrolytes in a very peculiar manner. The only conditions required are that the E.M.F. and current density shall be very high. On passing an electric current through a solution of disodium-hydrogen phosphate, between electrodes of sheet lead, I noticed nothing unusual during the experiment. The solution had a very high resistance and very little current passed even with a high E.M.F. At the close of the experiment, there being no switch in the circuit, the current was interrupted by lifting one of the electrodes out of the solution. It happened to be the negative electrode. At the instant of final contact between the electrolyte and the lowest point of the electrode as it left the solution, I noticed what appeared to be a cloud of black smoke or precipitate which had suddenly formed in the solution. On examining the cloud more particularly, and repeating the experiment several times, I found that by exposing only a very small surface of the negative electrode to the solution, there was produced a voluminous cloud of dark-blue or lead-coloured precipitate, which rapidly sank in the solution and rendered it entirely opaque.

It was then observed that the lead cathode was being rapidly eaten away, and that the precipitate was being produced at the expense of the lead. The precipitate was collected on a filter, washed with water and alcohol, and dried. It was found to be an impalpable powder resembling lead, and permanent in the air at ordinary temperatures. When rubbed in an agate mortar it was reduced to a lustreless gummy mass, but did not assume a metallic appearance. Heated to the melting point of lead in the open air, it suddenly absorbed oxygen and formed yellow plumbic oxide, with incandescence. Heated in a glass tube, in absence of oxygen, it melted to a globule of metallic acid.

In this bottle I show you a sample of this product that has been preserved more than two years without any apparent change.

The surface of the lead cathode, after the experiment, exhibited a peculiar appearance. It was reduced to a point at the end, and presented a smooth, shiny surface, like polished lead. It was of the form we should expect to find a positive electrode of copper or other soluble metal.

Other electrolytes were tried, and it was found that the lead precipitate could be produced in some solutions, but not in others.

The precipitate could not be formed in solutions of metallic salts from which a metal can be deposited by electrolysis. It cannot be formed in strong acids having a great affinity for lead. With ammonium oxalate and a positive electrode of platinum, there was formed on the platinum wire what appeared to be a deposit of lead peroxide, although no lead was originally in the solution. In a recent experiment I failed to produce this result.

Similar experiments were made with negative electrodes of iron, zinc, cobalt, nickel, manganese, magnesium, aluminium, copper, cadmium, silver, gold, platinum, bismuth, arsenic, antimony, and tin. Of these, arsenic alone acted in a manner somewhat similar to lead, being rapidly disintegrated as a negative electrode. The surface of the metal where the action took place was smooth, bright, and rounded, apparently polished. A film of brown, solid arsenic hydride was formed, which, instead of sinking, floated away from the electrode in straight lines on the surface of the solution. This hydride was also produced electrolytically by Sir Humphrey Davy. With lead electrodes, in a solution of sodium phosphate, some hydrogen phosphide was produced along with the lead precipitate. With borax and lead electrodes, the lead precipitate was formed very rapidly; and when the negative electrode was held close to the side of the glass beaker a bright reddish-brown stratum of liquid was seen to be continually formed at the surface of the electrode. This disappeared almost instantly after moving away from the electrode, but was continually formed as long as the current was strong enough to produce the lead precipitate. The addition of acetic acid did not prevent this formation.

Sodium thiosulphate gave a deposit of sulphur at the positive pole, confirming the theory that in the thiosulphates one atom of sulphur is electro-negative, and takes the place of an atom of oxygen in the sulphates. With sodium sulphite, sulphur dioxide was liberated at the positive plate. Strontium nitrate, instead of giving the lead powder, gave a blue flame around the point of the lead cathode.

These results seem to indicate the possibility of obtaining, by the use of high E.M.F. and high current density in electrolysis, products of an entirely different nature from those of ordinary electrolysis.

* Abstract of a paper read at a meeting of the Electrical Section of the Franklin Institute by Mr. C. J. Reed.

REDUCING THE COST OF ELECTRIC LIGHT.*

BY NELSON W. PERRY.

(Concluded from page 455.)

What promises to be a better method is one that has been tried on a small scale abroad, but not yet to any extent in this country—viz., encouraging the use of current during the hours of light load by reducing the price of service during those hours. The central-station manager could well afford to reduce his price to a mere fraction of what he now charges, if by that means he could obtain a steady demand for his product throughout the 24 hours.

Mr. H. Ward Leonard, who has given this subject more study perhaps than anyone else in this country, said in a paper recently read before the American Institute of Electrical Engineers: "If central-station companies would offer such a discount due to load-factor as to warrant their individual customers in installing at their own expense a storage plant which they could charge at the minimum rate per kilowatt-hour, and then use this stored energy to supply their occasional demands, I believe it is possible that the central-station companies, the storage battery companies, and the consumers might all derive a profit from the arrangement. I have no doubt that a central-station company could afford to make a rate of four cents per kilowatt-hour for a continuous service night and day, and make a satisfactory profit, while it would surely lose money in supplying an elevator at 15 cents per kilowatt-hour." If electrical energy were supplied to a customer at the lower figure, it would mean electric light at about $\frac{1}{6}$ cent an hour instead of 1 cent as now charged, or $\frac{3}{4}$ cent for gaslight, where gas costs 1·50dol. per 1,000 cubic feet.

In this connection he gives the following schedule of rates which he thinks should be charged per kilowatt-hour to customers, according to the proportion of the 24 hours they use current, together with the resultant gross income that these charges would bring into the central station:

Load-factor.	Rate per K.W. hour in cents.	Resultant gross income per annum per K.W. of plant.
5	30	$131·40
10	20	175·20
15	16	210·24
20	13	227·76
25	11·2	245·28
30	10	262·80
35	9·2	281·07
40	8·5	297·84
50	7	306·60
60	6	315·36
70	5·3	325·00
80	4·8	336·38
90	4·4	346·89
100	4	350·40

It will be noticed that, although when the customer uses current but 5 per cent. of the time (which is better than the average of electric light consumers) he is charged seven and a half times as much per kilowatt-hour as when

* From the *Engineering Magazine*. New York.

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using it continuously, the gross income to the central station is only about one-third what it is from the lower figure. Or, in other words, the central-station company would, according to these figures, get a gross return nearly three times as great by selling its current to a customer who would take it constantly at a rate of ⅛ cent per lamp per hour than it would get from the customer who used his light but 1½ hours per day, and who paid it at the rate of 1¼ cents per lamp per hour.

Doubtless some such arrangement as here suggested will in time be resorted to in this country to the advantage both of the consumer and the manufacturer.

Then there is another method by which relief may be obtained—viz., by finding some by-product for the central-station man to manufacture during the hours of light load. I use the term "by-product" advisedly, for it must be something whose manufacture may be stopped the moment the machinery is required for the main business. The manufacture of ice is one such "by-product" that has found some favour among central-station men; but while this may give employment to boilers and engines during the daytime in summer, the dynamos are lying idle even during the few months when there is a demand for ice, and during the winter months such a plan would afford no relief whatever. It would be far preferable if some electrical product could be found, for this would give employment to all of the machinery at all times of the year when not otherwise required. This, in fact, is the invention which is most required at the present day, and seems more possible of attainment than any other form of relief thus far suggested.

One of the recent products of the electrical furnace that looks promising for this purpose is calcium carbide—a product not new to chemistry, but new to commerce. This substance, which is produced by the fusion of lime and coal dust in the electric arc, when decomposed by the simple addition of water gives rise to acetylene gas—one of the most highly luminous gases known, as well as possessing the highest calorific powers of any of the hydro-carbon gases. We, on this side of the Atlantic, have been rather sceptical as to the advisability or practicability of undertaking the manufacture of calcium carbide, but the proposition has been given a standing which at least makes it worthy of consideration by our continental friends who are about to undertake it. It seems that a company has actually been formed in Germany for this purpose, known as the "Gesellschaft zur Verwerthung von Acetylen-gas." That this is no mere haphazard, ill-digested concern is evidenced by the fact that the great German electrical concern of Siemens and Halske has taken a substantial interest in the project. Should the undertaking prove a commercial one, it will be of the utmost import to the central-station man, and the outcome will be awaited with the greatest interest.

The commercial status of the manufacture remains, however, to be proved. There are two other products, however, already objects of commercial manufacture, whose status is already determined. One of these is aluminium and the other carborundum. These articles are already being manufactured on a large scale, and their manufacturers are seeking cheaper power at Niagara to enable them to increase their outputs at lower figures. The question arises, Would it not pay the central-station man to manufacture these products during the hours of light load at a figure with which even the cheap water powers at Niagara could not compete, if by this means he could keep all his apparatus occupied at its best rate throughout the 24 hours, and thereby reduce the cost of his electric light by from 50 to 75 per cent.?

As indicating the cost of power in ordinary practice when it is produced in a fairly continuous manner, I may cite the case of the Chelsea Jute Mills, of Brooklyn, which, during a period of six days, while developing an average of 653·3 i.h.p., consumed but 1·482lb. of coal per indicated horse-power per hour. This is equivalent, if we assume a combined engine and dynamo efficiency of 81 per cent., to a consumption of 1·83lb. per electrical horse-power hour.

During this time the load was by no means constant, but varied between 495·21 h.p. and 764·96 h.p. The equipment consisted of Corliss compound condensing engines and vertical tubular boilers, and was in operation 10 hours each day. The figures given cover the whole amount of fuel used, including banking, etc. Most of our modern electric lighting stations have quite as good an equipment as this, and yet statistics show that the best of them average 7lb. to 8lb. of coal.

The demand of the day, therefore, is not better dynamos, better engines, better boilers, or better methods of transmission, but steadier jobs for the apparatus we have, and he who will invent that job will do a better service to the electrical industry than he who invents a new electrical system.

INSTITUTION OF ELECTRICAL ENGINEERS, Apr. 25.

SIR DAVID SALOMONS, Bart. (Vice-President), in the chair.

At last night's meeting of the Institution the following candidates were balloted for:

Member.—Francis George Hart, 28, Victoria-street, Westminster

Associates.—Joseph N. Atkinson, 14, Cornwall-street, St. George's-square; Henry Brazil, care of Messrs. Siemens Bros. and Co., Woolwich, S.E.; Arthur Edward Hadley, "St. Kilda," The Ridgway, Wimbledon, S.W.; William Henry Nimmo, Melbourne, Victoria; Henley Phillips, 102, North End-road, West Kensington, W.; Sydney Louis Rhys Price, Faraday House, Charing Cross-road, W.C.

Student.—Harry Hughes Harrison, 55, Roxwell-road, Shepherd's Bush, W.

The following paper was then read on

A MAGNETIC TESTER FOR MEASURING HYSTERESIS IN SHEET IRON.

BY PROF. EWING, F.R.S., MEMBER.

Makers of transformers are now generally alive to the paramount importance, from the point of view of all-day efficiency, of using iron in which the hysteresis losses are small. The need, however, is felt of some simple means by which this quality can be readily determined. Tests made by the ballistic and other methods have shown that different samples of iron may exhibit extraordinarily wide differences in regard to hysteresis. The author has found, for example, in the course of his own tests of iron supplied for transformers, a range of nearly three to one in the hysteresis of good and bad samples. It is unnecessary to point out how much the all-day efficiency of a transformer working under ordinary conditions will be affected if the sheet iron used in its construction has three times as much hysteresis as it need have. Again, experience shows that even in one batch of plates of the same rolling so much difference is apt to exist between one plate and another as to make the testing of a single sample furnish a poor guide to the average quality of the batch. Even in a single plate samples cut from different parts show marked differences in hysteresis. The author has noticed as much as 15 per cent. variation in samples taken from the four corners of a plate not quite 2ft. square, the material of which was of very excellent quality. It is well known that different analyses of the nearly pure iron of which such plates are rolled exhibit corresponding variations. The impurities appear to be unequally distributed; and, further, it is not unlikely that the irregularities which are found in the magnetic quality depend in part on slight differences in the treatment as regards annealing. Whatever their cause, there can be no doubt that they exist, and their existence makes the result of a single test often somewhat fallacious. What is wanted is a sufficiently large number of tests, in any one batch of iron, to allow a fair average to be estimated for the quality of the batch.

To make this possible a simple and expeditious method of testing is imperative. The ballistic method, although unimpeachable on the score of accuracy, is anything but expeditious, and can scarcely be called simple. The value of the hysteresis is arrived at by first observing the relation of the induction, B, to the magnetising force, H, for a consideral number of points in each of a series of cyclic processes of magnetisation, then drawing the B H curve for each of these cycles and measuring the enclosed area. The operation requires some skill and experience, and a good deal of patience. The same criticism applies to other methods of finding the hysteresis by first finding the relation of magnetism to magnetising force—as, for instance, by the permeameter or by the author's magnetic curve tracer. It must be borne in mind that in the testing of transformer iron the permeability is a quite secondary matter. What is of primary importance is the hysteresis, and high permeability is not necessarily or invariably found associated with small hysteresis. In the testing of sheet iron by the ballistic method the finding of the relation of B to H is a step in the process; it is not the object of the test.

These considerations have led the author to devise an apparatus which measures the hysteresis directly by a single

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operation, and in a manner sufficiently simple to allow the test to be applied to numerous specimens without much expenditure of time, trouble, or iron. The basis of the instrument is the mechanical measurement of the work done in causing reversals of magnetism to take place in the iron under examination. Such measurements have been made before as a laboratory experiment and under special conditions. Thus Mr. L. R. Wilberforce and the author two or three years ago endeavoured to determine the hysteresis of a cylinder of iron when rotated in a strong magnetic field by measuring the couple required to keep it slowly turning; and a method of the same general character has been employed with complete success by Mr. F. G. Baily to investigate the disappearance of hysteresis which takes place in such a cylinder when the field is made sufficiently strong—a matter of great interest in connection with the molecular theory of magnetism. In the machine now brought forward as a practical tester for workshop use the same mechanical principle is involved. The process of reversal, however, resembles that which occurs in a transformer rather than in a dynamo; the induction is caused to have practically the same value in all samples, and that a value appropriate from the transformer point of view; the sample is cut in a very simple form, and is arranged to be readily inserted and removed. The magnetism is reversed by turning a handle, and the result is given by the position of a pointer on a scale.

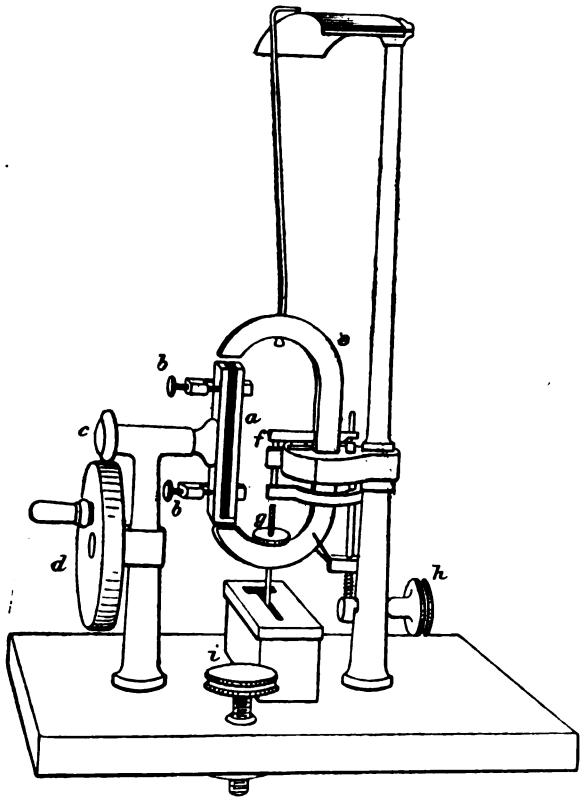

FIG. 1.

Fig. 1 is a drawing of the instrument now exhibited, the form of which has been reached after a good deal of experiment. The iron to be tested is cut or stamped in the form of strips, which are 3in. long and $\frac{3}{8}$in. wide in this instance. The number of these pieces that is taken to compose the sample depends on the thickness of the sheet; six or seven pieces will in general be sufficient for the usual gauges of transformer iron, and a smaller number if the material tested is the thicker sheet used in dynamo armatures. The bundle of pieces forming the sample is placed in a carrier, *a*, and is covered with a vulcanite washer and secured by two clamps, *b b*. The carrier is made to rotate by means of the friction pulley, *c*, and driving wheel, *d*. This causes the sample to revolve between the poles of the permanent magnet, *e*, with the effect that its magnetism is periodically reversed. The work done in reversing the magnetism, in consequence of hysteresis, causes a mechanical moment to be exerted by the revolving sample upon the magnet; and the magnet, being supported on a knife-edge at *f* in line with the axis of the carrier, tends to follow the sample and is deflected through an angle which serves to measure the work expended. Since a definite amount of work is done per reversal, whatever the frequency (so long as that is not so high as to make a sensible addition to the work by inducing currents), the deflection of the field magnet is independent of the speed at which the carrier revolves, and no special care has to be taken to turn the handle at a uniform rate. If the rate is very slow the magnet will show each individual impulse which it receives as the ends of the sample pass its poles, but when the speed is sufficiently raised these impulses blend into a steady deflection; and the speed may be further augmented, to the extent of doubling it, or more, without making the deflection change. It is only at higher speeds still that the effects of induced currents become apparent. The deflection is observed by means of a pointer and scale above the magnet. The swinging of the magnet is checked by means of a dash-pot below, consisting of a vane, or spade, moving in a box filled with oil. The stability is adjusted to give any required degree of sensitiveness by means of the weight, *g*, which travels as a nut upon a screw fixed to the magnet, and serves to raise or lower the centre of gravity of the oscillating system. The magnet swings about a knife-edge working in an agate trough, and a lifting arrangement like that of a balance is provided, operated by the handle, *h*, to save the knife-edge from unnecessary wear or injury. The pointer is set to zero in the middle of the scale by means of a nut which runs on a screw projecting sideways from the middle of the magnet, and a more delicate adjustment of the zero may be effected by means of the levelling screw, *i*. In operating, the observer inserts the sample and secures it by the clamps, then begins to turn the handle and lets the magnet down on its knife-edge. After reading the deflection of the pointer to one side he reverses the direction of rotation, reads the deflection to the other side, and takes the sum of the two readings as the total deflection. The deflection is proportional,

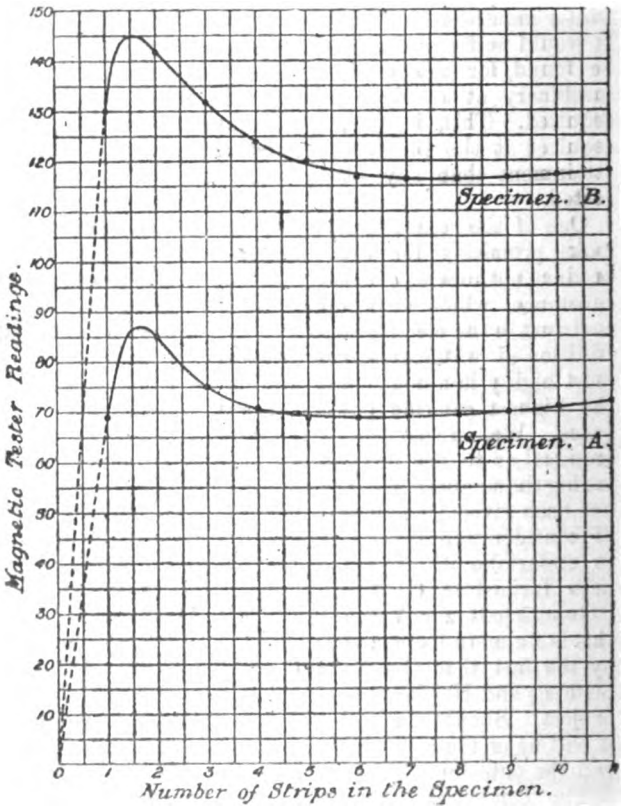

FIG. 2.

or very approximately proportional, to the hysteresis of the iron, even when samples widely different in quality are compared.

To secure that this shall be so, a considerable air-space is left between the magnet poles and the ends of the samples, with the result that such variations of permeability as are liable to be met with in different samples are almost without influence upon the total induction through the iron. The author has examined the induction by means of a search coil wound round the sample, and has found it to be practically the same in the best and worst specimens of transformer iron. The dimensions and strength of the field magnet are so proportioned, with reference to the section of the sample and to the extent of the air-gaps, as to make the induction have a value fairly representative of transformer work. In the instrument shown the induction is about 4,000 C.G.S. units with the normal size of test sample. By increasing or reducing the area of section of the sample the intensity of the induction is reduced or increased. Within reasonable limits, however, any value of this intensity may be adopted in testing, for it is known from the results of ordinary ballistic tests that curves drawn to show the relation of the hysteresis loss to B preserve their relative positions through a wide range of values of B. In other words, the relative amounts of hysteresis in different samples do not change, or scarcely change, when the iron is more strongly or less strongly magnetised. This, of course, follows from the fact that a formula of the type originally suggested by Mr. Steinmetz,

$$\text{Hysteresis loss} = c\,B^n,$$

is practically applicable, *c* and *n* being constants, within limits

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which are more than sufficiently wide to include the inductions used in transformers.

In cutting the pieces which are to make up the sample care has to be taken to make the length always the same, otherwise the air-gaps, and consequently the induction, will vary irregularly. The carrier is formed so that it serves on a length gauge, and to facilitate the preparation of the samples a supplementary gauge is furnished in the form of a clamp of hardened steel, in which the strips are readily filed to the exact length after being cut a trifle too long. The width of the pieces requires no particular care.

The author was under the expectation that it would be necessary, in making an accurate comparison of quality between different specimens, to give the sample the same weight in each case in order to make it have the same cross-section. He finds, however, that no nice adjustment of the weight is required, provided advantage is taken of a property which will be most easily explained by citing an experiment made with the tester.

The experiment in question shows the effect of varying the section of the iron by varying the number of strips which make up the sample. Eleven strips of thin transformer iron were taken, each 3in. long by $\frac{5}{8}$in. wide, cut from the same plate. These were all used to form the sample in the first instance; then one was removed, and the remaining 10 were tested, then nine, and so on, until finally the sample under test consisted of a single strip. The following are the scale readings for this, and also for another exactly similar experiment, which was made with a different specimen of transformer iron, of a poorer quality than the first. The two specimens are distinguished as A and B:

Number of strips in sample.	Scale readings of magnetic tester. (Specimen A.)	(Specimen B.)
11	72	118
10	71	117½
9	70	117
8	69½	116½
7	69	116½
6	69	117
5	69	120
4	71	124
3	75	132
2	85	142
1	69	130

These results are also shown in the curves of Fig. 2. It will be seen that both curves have the same general character, and that the scale readings of the tester pass a very flat minimum when about seven pieces form the sample. Whether six, seven, or eight pieces be used, there is no material difference in the readings. Precisely similar results are given by other specimens. Hence, if a weight is chosen equal to that of seven pieces of this material as a general standard, it will suffice, in preparing other samples for test, to select that number of strips which will give a weight approximating even roughly to the standard weight. The nearest whole number of strips will do, and it is not necessary to cut a narrow or wide strip to make up the exact weight.

When only two or three strips of this thin iron are taken, the work expended in reversing the magnetism of the bundle is increased. The total induction through the sample is somewhat diminished, but the intensity is increased, and this more than compensates for the smaller volume of iron that is being operated on. It is only when the sample is reduced to a single piece that the saturation of the iron prevents B from increasing sufficiently to continue this effect, and there is then a sharp fall in the curve.

These considerations have led to the use of samples the aggregate thickness of which is equal to that of six or seven thin transformer plates. In testing armature plates the same weight is approximated to by taking a smaller number of pieces. It is scarcely necessary to add that solid pieces or bundles of wire may be tested as well as sheet iron.

Calibration.—An extensive series of experiments has been made in order to determine to what degree of accuracy the readings of this magnetic tester correspond to the hysteresis losses as found by ballistic tests for various samples of iron. For this purpose it was necessary to test each identical sample in as nearly as might be the same state, first ballistically, and then in the new tester. In view of the variations which are observed between one part of a plate and another, the author did not feel that it would be satisfactory to use separate pieces for the ballistic observations and for the observations to be made with the tester. After some consideration, he adopted the following two plans:

In the first place, the ballistic tests were made on rings, each consisting of a long strip cut to the width subsequently wanted in the magnetic tester—namely, $\frac{5}{8}$in. This was bent into a ring, the ends just overlapping. After bending, the ring was annealed in a gas flame to get rid of the hardness produced by the bending. This is a most essential step, for in good iron the process of coiling into a ring, even of large diameter, hardens the metal very perceptibly, and increases the hysteresis. Then the ring was tested ballistically, a sufficient number of cycles being taken to allow a curve to be drawn showing the relation of the hysteresis loss, or $\int H\,d\,I$, to B, from B=2,000 to B=8,000 or so. The same thing was done with each ring. Then the rings were uncoiled and cut up into 3in. lengths for the tester, and the pieces were straightened and annealed to get rid of the hardness due to this straining. The whole number of pieces into which each ring had been cut were then dealt out into packs of six (or five, or seven, according to the thickness of the material), and these packs were shuffled until repeated trials in the tester showed that every pack gave nearly the same scale reading. The mean scale reading for the several packs obtained from each ring was then taken as a mean applicable to that ring. Here it was assumed that the first and second annealings might be held to bring the material into the same physical state.

To guard against any uncertainty on this point, four additional trials were made, using a different procedure. Long strips were again cut, but each of them was tested ballistically in its original straight form in a solenoid with open ends, the induction coil being wound over the central region only. Each strip was 36in. long and $\frac{5}{8}$in. wide, and a single strip was used in each test. The general effect of the free ends is to shear over the B H diagram, but not to alter the enclosed area. Enough areas were measured to determine, as before, the curve of $\int H\,d\,I$ and B for each strip. The strips were then cut up into pieces for the tester, which were treated as in the former case. In this procedure there was no annealing.

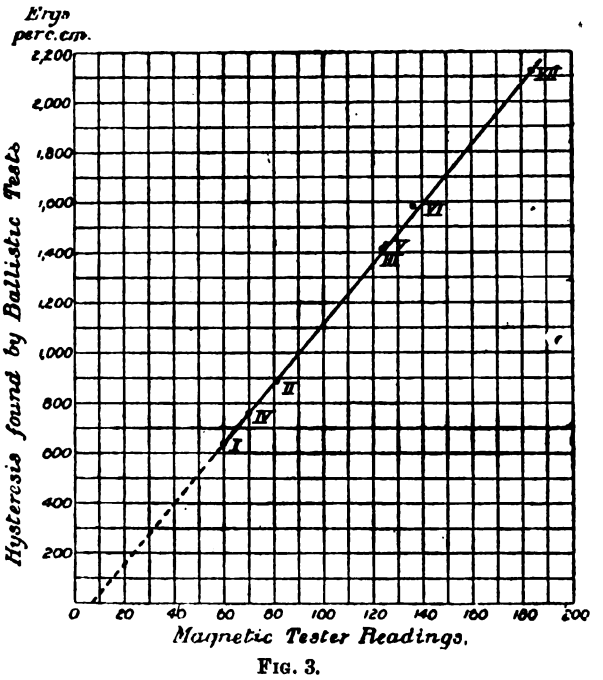

FIG. 3.

By these two means seven standard samples in all were produced of quality ranging from exceptionally good to exceptionally bad. The magnetic tester readings for these were taken, using approximately equal weights to form the sample in each case. In the following table the tester readings are given alongside of the value of the hysteresis loss ($\int H\,d\,I$) as determined ballistically for an induction, B, of 4,000 units for each of the seven specimens. Numbers I., II., and III. were those tested ballistically in the ring form; the others were tested in the form of straight strips.

Comparison of Magnetic Tester Readings with the Hysteresis Loss Determined by Ballistic Tests.

No. of specimen.	Magnetic tester scale readings.	Hysteresis loss by ballistic tests. Ergs per c.cm.
I.	60	640
II.	81	890
III.	124½	1,420
IV.	70	750
V.	125½	1,430
VI.	136	1,580
VII.	184	2,120

The same results are shown graphically in Fig. 3. It will be seen that they accord well with one another, and that the scale reading of the magnetic tester is nearly proportional to the hysteresis loss. A straight line drawn from the origin among the observed points lies sufficiently near all of them to allow the assumption to be made, so far as workshop testing is concerned, that the deflection in the tester, when multiplied by a factor depending on the sensitiveness of the instrument, is a practical measure of the hysteresis.

More exactly, however, the locus of the points is seen to be a straight line passing not quite through the origin. This

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may be partly due to the fact that the induction produced in the tester is not absolutely so high in the bad as in the good iron. In all probability, however, it is mainly due to this—that as the sample revolves some small amount of work is done in periodically changing the distribution of magnetism in the field magnet itself, in addition to the work that is done in reversing the magnetism of the sample. Any work expended within the field magnet would contribute to the deflection, and would exist even if the sample (while retaining its permeability) were entirely destitute of hysteresis. Hence the line may be expected to pass a little to the right of the origin, as it is actually found to do.

It is intended to furnish with each instrument two standard samples of iron, along with a table stating their hysteresis as found by reference to ballistic experiments (in ergs per cubic centimetre, and also in watts per pound, at an assigned frequency). In proceeding to test other samples the operator will first note the deflection given by each of his standard pieces, and then, by simple proportion, or by aid of a diagram, he may go on to interpret in absolute measure the deflection observed with any specimen. This will make his results independent of any loss of strength on the part of the field magnet, or of any changes he may find it convenient to make in the sensibility of the instrument.

The hysteresis of the standard samples is stated for B = 4,000. To find the hysteresis for any other induction it is only necessary to use the following table of factors, which has been deduced by the author as a general mean from ballistic tests of many samples:

Induction, B.	Relative amount of hysteresis.
2,000	0·33
2,500	0·47
3,000	0·63
4,000	1·00
5,000	1·41
6,000	1·89
7,000	2·41
8,000	3·00

Other forms of the instrument can be constructed by making the field revolve while the sample is pivoted, so that the sample deflects; by placing the axis vertical instead of horizontal, with a control furnished by a spring or by bifilar suspension; by using a weighted arm or torsion head to measure the deflecting couple, instead of observing the deflection by a pointer on a scale, and so forth. But the author believes that the form now exhibited will be found both accurate and handy in general use.

He hopes it may contribute indirectly to the betterment of the iron used for magnetic purposes, by making it easy for a purchaser of iron or a purchaser of transformers to specify a maximum of hysteresis, and to see that he gets what he specifies. A notable improvement in the quality of sheet iron in this respect has been going on during the last few years, and it is now practicable to get iron which a short time ago would have been pronounced impossibly good. But it would be easy to quote tests showing that some iron of relatively very poor quality still finds its way into armature and transformer cores. The author's aim has been to put into the hands of those who are practically concerned with magnetic hysteresis, whether as makers of plates, builders of transformers, or engineers of alternate-current supply stations, an apparatus in which testing is reduced to its simplest terms, where each test consumes no more than a few square inches of the sheet, where the preparation and testing of the sample take only a few minutes of time, and the operation consists in turning a handle and reading how good or bad the iron is from the position of a pointer on a scale.

Discussion.

The **Chairman** stated that the paper would have been most welcome three or four years ago. The instrument would have been useful in laboratory work, but would be more so now to manufacturers. It would also be of value to the public as tending to cheapen the cost of current.

Prof. Fleming said it was impossible not to admire this simple solution of a practical question. The instrument had three merits—viz., that it was independent of steadiness; that it worked with small samples; and that the operation took a short time. These facts would make it very useful for workshop use. He wanted to know why the specimen was revolved instead of the magnet being revolved. An obvious modification was to make the field travel in various ways, though possibly this would not be an improvement. No one was much in love with ballistic methods, and thanks were due to Prof. Ewing for his invention.

Prof. Carey Foster echoed Dr. Fleming's thanks to Prof. Ewing. He thought, at first sight, that it would be possible to cause the magnet to move by rotating even a piece of wood, which would act as a fan. Possibly magnetic viscosity might act on the instrument in the same way as hysteresis.

Prof. Ayrton, with reference to the instrument, stated that he would like to learn if one wanted to know the hysteresis of different inductions whether it would work well. It should not be forgotten that hysteresis was not all that a designer of dynamos wanted to know, but permeability also, and it would not be a roundabout method to get at hysteresis by getting the permeability. Some years ago he had made a machine which allowed of the B H curve to be got quickly. He made a small separately-excited dynamo, using the specimen to be tested as the yoke, by which both the permeability and the hysteresis were obtainable.

Prof. Forbes congratulated the author on having produced an instrument which commended itself specially as a practical instrument rather than a laboratory one. The straightness of the lines in Fig. 2 were sufficient for all practical purposes.

Mr. Siemens said he had brought before the Institution in a paper some results by ballistic measurements, and he might get some of the author's measurements, but he thought he would stick, on the whole, to ballistic measurements. His reason was, that in testing for hysteresis, you should interfere with the iron as little as possible, whereas the specimens were filed for the author's apparatus. The instrument, however, was very handy, and likely to be extensively used,

Mr. Ferranti considered that the instrument would do well in engineering practice.

Mr. Esson said the machine was one which had been wanted for a long time, and only manufacturers could appreciate its value.

Prof. Ewing, in reply, thanked the speakers for their cordial appreciation of the instrument. He had, in his earlier experiments, found that to revolve the magnet was not the best plan, as the specimen did not always have the same stability. With regard to fan action, this did not exist, as might be seen by revolving the handle without any specimen or with a piece of wood. Eddy currents he had found to be of no importance, and the brass clamps were insulated with vulcanite. The machine was one primarily for the shop, but he disagreed with the suggestion that it was not also one for the laboratory. He used it himself in preference to the ballistic method for all except a comparatively small number of purposes. There would be many points enquired into when such a short and simple system could be used that would be left undone with the ballistic system.

THE USE OF ELECTRICITY FOR COOKING AND HEATING.*

BY R. E. CROMPTON.

Up to the present time, the utilisation of electrical energy, laid on now so universally in our houses for lighting purposes, for the further purposes of heating and cooking has been regarded by the public, and even by many who have technical knowledge, as impracticable, and certainly as too costly, to be adopted.

It will be my object this evening to show you that, far from this being the case, heating and cooking by electricity has now advanced to a highly practical and useful stage. No doubt these erroneous impressions have arisen chiefly from the fact that the advocates of electric lighting have from the first dinned into the ears of the public that one of the chief advantages of electric lighting is that by it light is furnished without heat; even those who put it more precisely showed that a 10-c.p. gas-jet heated the air of a living-room 13 times more than a 10-c.p. electric incandescent lamp, and it was the knowledge of these facts that prevented electrical engineers from carefully examining the problems connected with electrical heating.

However, at very early periods, Siemens showed that where intense heat is required to be concentrated in a small space the electric arc forms a very convenient furnace, and in many cases actually possesses economical advantages. This principle was practically adopted by Cowles for his earlier furnaces for reducing aluminium, and has been also used for electrical welding by the Benardos process.

But for the production of the heat we require for warming rooms or for cooking food little or nothing was done until about four years ago, for although Lane Fox was the first to point out, in his 1878 patent, that electrical heating could be satisfactorily carried out by placing the food or other materials to be heated in a vessel surrounded by a coil of insulated wire through which a current should be passed, nothing appears to have been attempted until about four years ago. Carpenter, in America, so far developed Lane Fox's ideas as to take out a patent for manufacturing electrical heating apparatus by attaching these resistance wires to the surface of cast-iron plates by an enamelling process, and a considerable amount of apparatus was manufactured by him in America on this principle; some of this was forwarded to England and was shown at work by Messrs. Crompton and Co. at the Crystal Palace Exhibition in 1891.

In practice it was then found that although Carpenter had done sufficient to show that electric heating could be usefully employed, yet that the apparatus at that time was not sufficiently durable to be of practical value. A number of serious defects made themselves evident, principally connected with the enamelling process; the enamel was found to crack, and the surface of the wire used was thus exposed to the oxidising action of the air. This action rapidly destroyed the wire, and thus broke the circuit.

It occurred to us that this difficulty might be surmounted if sufficient time were spent on a research into the nature of the

* Paper read before the Society of Arts, April 24.

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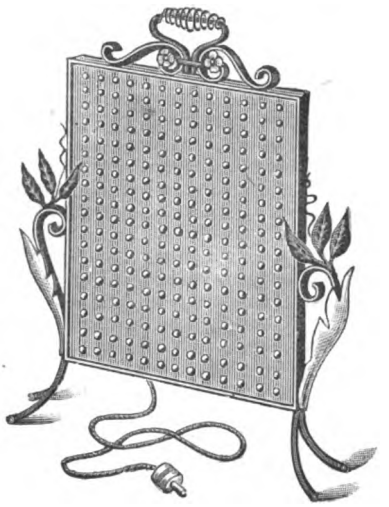
metals best suited to stand the frequent heatings and coolings to which the apparatus is subject, and which at the same time would have a coefficient of linear expansion so nearly the same as that of the enamels used, and of the plates to which the wires is attached by these enamels, that the tendency to crack which is caused by unequal expansion would be overcome.

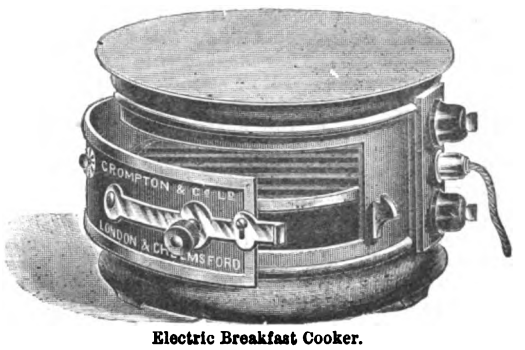
After a long course of experiments, we found that several of the nickel-steel alloys, varying in composition from pure nickel to others containing quite a large proportion of steel, were well suited for the purpose, and in all respects were far superior to the German-silver alloys which had been used in America. We also found that if we substituted for the homogeneous enamel used by Carpenter a composite enamel consisting of two or more layers, the lower one being of the hardest and most refractory character, we were able to obtain very satisfactory results. We have been able to use an enamel consisting



Electric Radiator.

almost entirely of silica for the groundwork—this fuses only at an exceedingly high temperature, almost approaching the welding point of wrought iron. We devised special machinery to artificially roughen the surface of the plates to which this first coat of enamel is to be applied, and we thus ensure that the layer of enamel between the wire and the plate to which it is attached is never even softened at the temperatures reached by our apparatus in ordinary working. We apply our nickel-steel wire in the form of a waved or crimped ribbon. This crimping is carried out by a special machine devised for the purpose.

This crimped ribbon is mounted on the surface of a "transfer plate," afterwards to be described, and it is from it transferred to the surface of the first coat of enamel, which has been already



Electric Breakfast Cooker.

raised to a temperature sufficient to soften it but not to melt it. We then cover the first enamel and the wire with powdered enamel of a more easily fusible nature, and we then raise the temperature of the whole to a sufficient degree to enable the second enamel to melt down and incorporate itself with the upper surface of the first coat of enamel, at the same time completely covering and insulating our wires. This process is one which has required much study and considerable manual dexterity on the part of the workmen, but once it was perfected it gave excellent results. It allows the wire to be heated to any degree desirable for ordinary heating or cooking operations without any fear of the enamel cracking so as to allow of access of air to the wire.

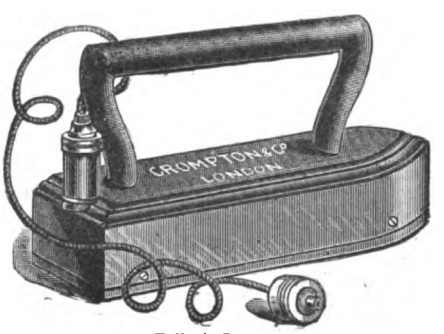
Not the least part of our difficulties was the preparation of the crimped wire and the designing of the transfer plates above referred to. We found that if we attempted to crimp the wire or arrange it in wavy patterns by hand that the wire was always liable to become thinner at each of the bends, and consequently the electrical resistance at these points was higher, and the heat developed greater, than that of the points intermediate between the bends. To avoid this, we had to devise a crimping machine, which crimped or corrugated the wire in such a manner as to avoid altering its cross-section. This machine takes the wire from a reel, crimps it, and delivers it in any desired pattern on to the surface of the transfer plates.

The transfer plates consist of a metal plate, to the back of which are attached a number of electromagnets in such a manner that when the crimped steel wire has been laid on its plate in any desired pattern or form, by exciting the electromagnets, they hold the wire and retain it firmly in position on the surface of the plate until it is desired to transfer it to the heated surface of the enamel; this can be done instantaneously by breaking the exciting circuit, so that the wire no longer adheres to the transfer plate. We have other methods of rapid transfer, but it is unnecessary to take up your time by describing them here, as the above method is fairly representative of the others.

By the above-described method we are able to apply the wire in somewhat complicated patterns to the surface of any metal plate, and to insulate it therefrom in a very thorough and permanent manner by our compound enamel. The only other difficulties which have arisen in connection with the enamel have been those due to unequal expansion and contraction of the terminals at the ends of the wire. At first we had some difficulty in arranging these so that the enamel did not crack, and allow the terminals to be burnt or oxidised at the point at which the wire leaves the enamel.

Electric Heater and Kettle.

The simplest form of apparatus in which we heat a plate by a current passing through a wire enamelled to its surface, is that which we call a heater. It is a cylindrical plate mounted on short legs, to the underside of which wire is applied and fixed by the enamel, the upper side being ground flat and polished. Such a heater can be put to many useful purposes: it can be used as a radiator of heat or as a means of heating dishes on the breakfast table, or for the purpose of drying linen or for warming or drying any article which it is inconvenient or dangerous to place near the fire. It can also be used for cooking purposes if the food is placed on flat dishes or pans, care being taken that the lower surface of the pan comes into close contact with the upper surface of the heater; but although cooking can be carried out in this manner, we do not recom-



Tailor's Iron.

mend the use of separate heaters, as there is always a loss from the lower surfaces of the pans not making sufficiently good contact with the upper surface of the heater, and we therefore prefer to ensure this contact by making the heating-plate form part of the kettle, saucepan, frying-pan, or other similar culinary utensil.

In the course of our experiments to determine the best and most efficient arrangements of our apparatus we met with great difficulties in what would appear a comparatively simple matter—the measuring of the temperatures we obtained. We found that the ordinary mercurial thermometer, however carefully it may be made, is not suitable for accurately indicating the temperature of the heated surfaces, as it really indicates the temperature of a stratum of air near to the heated surface instead of that of the surface itself. After trying Calender's improved form of the Siemens electric pyrometer, we eventually adopted for our measurements of temperature my own form of platinum thermometer, a description of which may interest you at this stage. This platinum thermometer, which measures temperature by showing the increase in resistance due to the rise in tem-

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perature of a delicate coil or platinum spiral placed in close contact with the heated surface, is made and used as follows.

The spiral consists of a thin strip of platinum only two-thousandths of an inch thick by one twenty-fifth of an inch wide; a sufficient length of this strip to have about five ohms resistance at the temperature of 0deg. C. is wound in a form of double spiral on to a strip of mica sheet about ½in. wide by 4in. long; this is enclosed and held between two similar sheets of mica fastened together at their edges by a sewing of very fine platinum wire. The total thickness of the spiral and its covering is not greatly in excess of that of a sheet of paper, so that the whole of the spiral can be brought within a distance of one-hundredth of an inch from the surface to be measured. It is arranged on an electrical circuit in series with a standard resistance made of manganin. The standard made of this alloy has practically no change in resistance due to change of temperature—*i.e.*, within the limits of air temperature, change of an ordinary room, or laboratory. Both platinum spiral and the standard manganin resistance are provided with couplings or terminal screws, by which any desired number of platinum spirals may be coupled in series with the manganin standard. A very small constant current from an accumulator cell is passed through the whole of them. Each of the platinum spirals, as well as the manganin standard, is provided with a pair of potential terminals, and at the time of first calibration they are carefully adjusted, so that the potential difference measured on a potentiometer is exactly equal. When the platinum spirals are plunged in melting ice, and the manganin resistance is at the ordinary laboratory, it is convenient to balance them at this point at 1,000 on the potentiometer scale. The platinum spirals are then exposed to the temperature of boiling water in a hypsometer, and if the platinum employed be pure the potential difference of the platinum spirals, when now compared with that of the standard, will be as 1,362 : 1,000. If this portion of the potentiometer scale between 1,000 and 1,362 be divided into 100 parts, each of these will be equal to 1deg. C. It is evident that any desired number of temperature readings may be taken by employing a corresponding number of platinum spirals, and comparing them in turn with a standard.

It is obvious that this method of taking temperatures presents many advantages over the employment of ordinary thermometers, as when these have to be used for taking temperatures of ovens or of the interior parts of meat, or of other food, the act of removing the thermometers to take the reading introduces errors of considerable magnitude, whereas with the arrangement I have just described it is possible to take accurate readings practically simultaneously of the temperature in various parts of the oven or other apparatus, and of various parts of a joint of meat, and in this way a great many interesting facts respecting cooking have come to light. By these means we have been able to measure, with a high degree of accuracy, the amount of electrical energy that is required for various forms of heating and cooking apparatus, and the accompanying four tables give a fair idea of the cost of heating of surfaces required:

—	Time.	Energy in B.O.T. units.	Cost at 4d. per unit.	Temperature, Fah. scale.
	Min.		d.	Deg.
Table I.	—	—	—	50
Showing energy required to raise a heater plate from 50deg. F. to 400deg. F. in half an hour.	10	0·116	·46	257
	14	0·164	·67	332
	21	0·248	1·0	337
	30	0·404	1·61	400
Table II.	—	—	—	50
Shows the energy required for a radiator plate, such as we use for heating the air of a room.	10	0 091	0·364	171
	30	0·277	1·1	240
	40	0·350	1·4	257
	50	0·430	1·72	261
	60	0·500	2·0	264
Table III. Shows the energy required for boiling 1lb. of water in a tea-table kettle.	—	—	—	50
	18	·075	0·32	212
Table IV. Shows energy required by a smaller kettle containing ½lb. of water—*i.e.*, sufficient for two cups of tea.	—	—	—	50
	12	·051	0·2	212

First, for roasting, or baking, or frying; the second table gives the cost of heating surfaces to a lower temperature, such as is required for warming the air of a room, or for airing linen, or for similar purposes; Tables III. and IV. give the cost of the energy required for boiling water in small quantities, and are interesting, as they show that even when we are using electricity in the manner in which it compares least favourably with solid fuel—*i.e.*, for the boiling of water—we can, with an ordinary electrical kettle, switch on the current and obtain a cup of tea at a cost of less than a farthing for a single cup, or half a farthing per cup if several are required.

Although these tables show the amount and cost of electrical energy required to raise various kinds of heating surfaces to a certain temperature, something more than this is necessary to enable you to form an opinion of the value of heating and cooking by electricity from the point of view of economy.

When the subject is first mentioned even to a skilled engineer, his first idea is that in almost every case electric heating must be too expensive to become general. He knows the wastefulness of steam generating plant is such that not more than 6 per cent. of the heat energy in the fuel can be distributed to the consumer in the form of electrical energy, and he is not to be blamed if he concludes from this that there is no chance of using the reconverted heat from this energy, in competition with the heat which the consumer can obtain direct from burning the fuel itself. But the fact is that all these opinions are based on an insufficient knowledge of the economy—or rather extraordinary want of economy of cooking—as carried on at present by the ordinary kitchen grate. Now that we can actually measure the heat that is required, and carry on cooking operations, we are astonished at the smallness of the results obtained by present methods. The percentage of the heat units of the coal burnt in our kitchens which is actually utilised in cooking the food is in all private houses, and in most hotels and clubs, so ridiculously small that I should hardly be believed if I quoted you the figures which we have obtained; it is not too much to say that in many cases not more than 2 per cent. is utilised. This enormous waste is due to the fact that with the sole exception of boiling and stewing all the remaining operations of cookery depend on the radiation of heat to the substance to be cooked. Take, for instance, the process of grilling a chop. Consider how much coke has to be burnt before a bed of glowing coke fit for the purpose is obtained, and after the clear grilling fire is in order, consider that 70 per cent. goes up the chimney, 16 per cent. is radiated into the room, or employed in roasting the cook, male or female, as the case may be, and it is not difficult to understand that the chop itself does not receive more than 2 per cent. of the total heat units. On the other hand, with a properly-arranged griller heated by electrical means fully 65 per cent. of the heat energy in the electricity is utilised in the meat. Take, again, the case of the ordinary oven attached to the kitchener of a small private house. The oven may be used on an average three hours a day, but if solid fuel is used the oven must be heated continuously from the time that the kitchen fire is alight in the morning until late at night, so that in this case the total heat usefully radiated from the sides of the oven to bake, to roast, or brown the food within it, generally amounts to a very trifling percentage of the fuel used.

The comparison with gas cooking, although not so striking as when solid fuel is used, is still very favourable to electricity, for although in the case of the gas oven considerable economy results from the gas being used only at the time that the oven is required for cooking, yet in this case the heat is communicated to the food by radiation from gas flames, so that it is necessary that a current of air must continuously pass through the oven in order to ventilate it, and carry away the products of combustion. This ventilating current also carried away with it at least 80 per cent. of the heat units obtained by burning the gas.

The electrical oven consists, as you see, of a rectangular box, having double sides at bottom, top, back, and front; the inner surfaces of the inner plates are the electric radiators, and the space between them and the outer plates is filled with a non-conducting material; the door closes practically airtight, no ventilating current of air is necessary, thus all waste of heat being prevented. In this case, when the oven is filled with food, more than 90 per cent. of the heat energy can be utilised, and thus, although possibly 5 to 6 per cent. only of the heat energy of the fuel is present in the electrical energy, 90 per cent. of this—or 4½ per cent. of the whole energy—actually goes into the food, and thus the electrical oven is practically twice as economical as any other oven, whether heated by solid fuel or by gas. Thus far I have dwelt at some length on the economical question; it is time to say something on the questions of the convenience and of the superior results which can be obtained by the electrical means. I have already spoken of the large loss by radiation which occurs when solid fuel is used, or to a less extent when gas fuel is used; this has the great inconvenience of injuring the quality of food that is being prepared in the kitchen, of keeping the cooks in a heated and unpleasantly perspiring condition—and I might enlarge considerably on this point. The electrically-worked kitchen may be kept as cool as a dairy if it be desired, and the effects on the quality of the cooking, and on the health and tempers of the staff, must be experienced before it can be fully appreciated. I have also mentioned, in the case of the gas oven, the necessity for allowing ventilating currents of air to pass over the surfaces which are cooling. These

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currents of air dry up and harden and take away the flavour of the outer portions of the meat; any connoisseur can detect this in the case of fruits cooked in a gas oven. With the electrical cooking, the absence of such ventilating currents and the stillness of the air prevents the above described drying and hardening action; the meat is found to be tender and juicy right up to the extreme outer surface, it is browned only to a sufficient extent to please the eye and the palate. Again, the facility for regulating the temperature to any degree of nicety which we can give with any of the electrical cookers or ovens, is being highly appreciated in the higher walks of the culinary art. Most skilled cooks will tell you that it takes much experience to satisfactorily manage an ordinary oven so as to bake or brown pastry or sweetmeats, and always give a uniform result. When these skilled cooks use electrical apparatus for the first time they almost invariably say, A child could learn the ways of this oven in a few hours and produce as good results with it, with absolute certainty, as I could with an ordinary oven after I had known it and learnt its ways for years.

All users of electric light are interested in the development of electric heating and cooking. You, all of you, have been told that the cost of electrical supply may be greatly reduced if it can be utilised during the daytime for other purposes in addition to lighting. Although the day may come—and I feel certain will come—that electricity will be used for power purposes within our homes to an extent undreamt of at the present time, yet such development must be necessarily of slow growth. We must be educated to the point of using power for many occupations and pursuits which have yet to be invented, but the day of electric cooking is not far distant. There is no reason why in a few years to come quite a majority of the users of electric light will do all cooking operations of the nature of roasting, baking, stewing, frying by electrical means—perhaps still employing solid fuel for boiling purposes only, and this in connection with a suitable furnace for supplying the whole of the hot water required for a household. Time does not allow me to go into very many interesting matters connected with electric welding, brazing, soldering, roasting of ores, drying of paints, and many other industrial operations in which electrical heating can be advantageously employed. I am also unable to do more than state the bare fact that the managers of several theatres—notably the Vaudeville—have found that electric radiators form a most convenient, safe, and economical method of heating the auditorium of a theatre. During the late severe frost these radiators were found to be a great convenience in large shop fronts to prevent the lowering of the temperature, and hence the freezing of the moisture on the plate glass, which otherwise obscured the contents of the windows. The apparatus, which is on exhibition in the room, is fairly representative of what is now supplied to the public.

DISCUSSION.

At the conclusion of the paper the author drew attention to the various exhibits, which included ovens, heaters, frying-pans, kettles, radiators, cigar-lighters, and a sealing-wax melter, the latter being described by Mr. Crompton as having been the last stronghold of gas in the City.

Mr. W. H. Preece, who occupied the chair, said he felt very much struck with the figures given as to the absolute waste of heat in our houses. He had been using many of the apparatus for some time, and found them very convenient. One electrical heating apparatus to which the author had not referred was the electrical poultice which Mr. Snaedeker, an American, had shown last year at the Royal Society. The speaker also referred to rail-welding, which he had seen in Boston.

Mr. Binswanger was thankful to Mr. Crompton for having taken up the subject of electrical cooking with such energy. The speaker could almost claim to have brought this branch of electrical engineering into England. Electrical cooking appliances not only performed their duties as well as others, but they had many advantages over the old-fashioned methods. He agreed with the author's figures, which would prove a lesson to electrical engineers.

Mr. Dowsing, after some questions had been asked, explained the nature of the ovens. They should not be used wastefully, like gas ovens. As regarded the electric heating of theatres, it was in itself dearer than ordinary methods, but it could be used more advantageously and a smaller quantity of heating was required. He doubted if electric radiators would compete with coal for a constant supply in big buildings, but they were cheaper than hot-water heating.

Mr. Crompton, in reply, said he believed that the apparatus now made was as durable as was desirable. He agreed with Mr. Binswanger that difficulties remained to be overcome in appliances where constant concentrated heat was required. With respect to the electrical poultice, he had experimented in that direction before the American gentleman made his appearance, but such appliances would only last a week or so. The success of electric cooking dated from the time of taking quantitative measurements. With respect to office heating, he believed radiators would be economical under certain circumstances.

At the conclusion of the proceedings the audience examined the apparatus exhibited, and consumed what had been cooked during the progress of the lecture.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Wednesday at Winchester House, Old Broad-street, Sir John Pender, M.P., occupying the chair.

The **Chairman**, in moving the adoption of the report of the directors, which was published in our last issue, said that he would first of all deal with the portion of the accounts which showed the growth of the undertaking. As long as customers continued to increase at their present rate and the areas occupied by the Company had to be filled up with the necessary networks of mains, expenditure on capital account for this purpose must continue to grow, while every addition meant the extension of profitable business. They had also expended on capital account £1,832 on buildings, £7,995 on machinery, and £2,703 on compensation. As regarded the expenditure on machinery, it was owing to new plant, which had been erected at Manchester-square station to meet the circumstances in which they had been placed in connection with the actions brought against them for vibration. It was impossible to carry out the remedial works without serious expense and great difficulty in maintaining a constant and regular supply, and, moreover, their working expenses showed a large increase in consequence of their other stations having been called upon to assist the Manchester-square works almost daily during the alterations. The machinery thrown out of use from these causes was doing excellent work elsewhere, so that they were now possessed of additional plant which it would have been in any case necessary to obtain to cope with their largely-increasing output. The item of compensation to which he had referred related entirely to payments made in connection with these lawsuits. The capital expenditure during the year naturally involved a provision of funds to meet it, and in dealing with this question the Board considered that they ought to be able to borrow on better terms than 5 per cent. In the result, a first mortgage debenture stock of 4½ per cent. was created to the extent of £250,000, of which £150,000 was issued last July at 105, that being the rate at which the old debentures had to be redeemed. This stock now stood at about 120. With the proceeds, the whole of the old debentures had been paid off, and the net premiums had been carried to the depreciation fund. Of the balance of £50,000 they had £21,000 in hand at the end of the year, but it would before long be necessary to make a further issue to keep pace with the rapid expansion of their business. Their revenue account showed a steady increase, being £16,150 more than in 1893, and the gross profits were £7,000 more. This improvement, satisfactory though it was, would have been larger had it not been for a somewhat heavy increase in working expenditure, partly owing to the higher price they had had to pay for coal, and partly also to the peculiar difficulties which the litigation referred to had forced upon them. The Board had also found it absolutely necessary to make certain reductions in favour of large consumers of current. While their receipts had thus been materially affected, the encouragement which this system of charging gave to use their current was beneficial as having a tendency to increase their day load. In one portion of their district also competition had to be met. After writing off the usual £1,000 from the preliminary expenses and setting aside a further £8,000 to depreciation, there remained a balance of £15,909, out of which they proposed to pay a dividend of 6s. a share and to carry forward £939. Referring to the amount written off for depreciation and the auditor's note on the subject, he stated that the Board did not in any way commit themselves to an opinion as to what amount should be written off on this account. Electric lighting was a business which was at present new and undeveloped. They had thought it best to err on the safe side, their desire being to make the foundation on which they built thoroughly sound. He was himself rather disappointed with the dividend, but when he saw the reasons for it he was satisfied that they were pursuing a sound policy. At the outset they anticipated receiving at least £1 a light, whereas the average sum they received was only 8s. 5½d. This, however, was not discouraging, owing to the growth of the Company. To-day they had about 224,829 lamps, and they had still a demand for 10,000, while, as far as he could see, with their present machinery they could go on to 300,000 lights. One reason for their not paying as large dividends as one or two other companies was that they had a much larger area, and had to lay down mains over a very considerable space. Great expense was incurred over these mains, but when they got a full demand for the light, having no increased expense, the Company would begin to reap what it was sowing at the present time. He therefore looked forward to the dividend steadily increasing. The demand was increasing, and they were building up the business on such a sound foundation that those who were in it now would have no cause to regret it. Their staff was highly efficient and well disciplined.

Admiral Sir G. H. Richards seconded the motion.

The **Chairman**, in answer to questions, said that their stations were very much inland, and this increased the price of their coal as compared with certain other companies who were more favourably situated in this respect. They were taking steps with the view of dealing with the competition they had to meet in one of their districts.

Mr. John Newton objected to the qualification in the auditors' certificate as to the accounts being correct "subject to the sufficiency of the charge for depreciation." He maintained that a company in its early stages which expended amply in maintain-

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ing its machinery and property was satisfying all reasonabel requirements as regarded depreciation, especially where, as in the case of their Company, the business was rapidly expanding.

The **Chairman**, in reply, remarked that the auditors were appointed to represent the interests of the shareholders, and the qualification referred to in their certificate had probably been inserted in the interest of the shareholders. He believed, however, that the directors took very much the same view as Mr. Newton.

Mr. John Griffiths, of the firm of Messrs. Deloitte, Dever, Griffiths, and Co., the auditors, stated that the reason for wording their certificate as they had done was that they had no certain knowledge up to the present time of what the depreciation was. The motion was then adopted.

The retiring directors (Sir George Richards, Sir Eyre Massey Shaw, K.C.B., and Mr. John B. Verity) were re elected, as were the auditors (Messrs. Deloitte, Dever, Griffiths, and Co.).

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

The annual general meeting of the above Company was held at Cannon-street Hotel on Monday last, the Right Hon. D. R. Plunket, Q.C , M P., occupying the chair.

The **Chairman**, in moving the adoption of the report (which we published in our last issue), said that it was really the first annual report in the history of the Company, for though there was presented last October a statement of the proceedings up to that time, it was rather in the nature of an interim statement. Their present position was extremely satisfactory. To begin with, there was a credit balance of £332. 5s. 10d. While the capital expenditure had been proportionately heavy, there was nothing in that to be regretted when the purposes to which the expenditure had been applied were considered. Their financial position showed every symptom of being a thoroughly sound one. Before referring to the Company's experiences in the way of acquiring controlling interest in concerns outside the county of London, he would deal with their operations within that limit. As to these, undoubtedly they had met with a certain amount of delay, caused mainly by opposition from local authorities, not because of any defects in the plans which were submitted to them, but on account of accidents which had occurred with other systems; and in consequence of the representations made by the London County Council and other local authorities, the Board of Trade had hesitated to grant their approval to the system of supply proposed by the Company until possessed of the fullest information. They were carrying out their arrangements of treet boxes and such matters in a way which would fully meet all the requirements suggested in Major Cardew's last report. Already the County Council and the local authority of St. Luke and Clerkenwell had so far approved their plans that they had been able to lay the whole of their pipes for mains and to complete their arrangements for drawing-in boxes within that district, and at the same time they had begun the erection of their station at the City-road basin of the Regent's Canal. They hoped to be able to supply current from that station by the end of September next. In Wandsworth the work had been held back pending the publication of the usual Board of Trade regulations, but they hoped that these would now almost immediately be issued. The purchase of the site for a generating station was completed, the plans far advanced, and tenders would as soon as possible be invited for the construction of the buildings. Their application for a provisional order for the district of St. Olave's, Southwark, had received the consent of the local authority, and this district, which included the two London Bridge stations and railway approach, would be a valuable addition to their area of supply on the southern side of the river, as it nearly adjoined the district of St. George-the-Martyr, for which they held a provisional order, and instead of having separate generating stations for each district, one would be sufficient for both. Turning to the position of their undertakings outside the county of London, he would first take the case of Bournemouth, where they had acquired the interest of the Brush Company in the Bournemouth and District Company. Since the spring there had been a very substantial increase in the number of consumers, and it had been necessary to find an additional sum of money in order to provide further plant and mains as required. Upon the completion of the work now in progress. the Bournemouth station would have a capacity of 27,000 8-c.p. lamps. At Dover, the generating station buildings were now complete. Some of the plant was at work supplying the lamps on the sea-front with current, and the remainder would shortly be delivered. Mains had been laid throughout the whole business portion of the town and to the outlying district of Buckland. Next, as to Windermere, the consents of the whole of the local authorities for the lighting of whose districts they had sought a provisional order had been obtained, with the exception of two—viz , seven towns out of nine—and they were not without hope that the two which still stood out (Kendal and Ambleside) would consider it to their advantage to join the others. Finally, turning to Richmond, in Surrey, the negotiations had been completed, and they had now secured upon reasonable terms for themselves a controlling interest in the existing Richmond Electric Light and Power Company, which ought to have a rapidly increasing value. Already the lamp connections were equivalent to over 4,400 8-c.p. lights, and with small additional expenditure double the number could easily be supplied. The question of electric traction and tramways at various places had been brought under their notice, and was receiving careful attention.

The motion for the adoption of the report was seconded by **Mr. J. B. Braithwaite**, and carried unanimously.

The retiring directors, the Right Hon. D. R. Plunket and Mr. F. W. Reynolds, were re-elected. Mr. R. H. Marsh was also re-elected auditor for the ensuing year.

A resolution was afterwards proposed by **Mr. George Herring** for increasing the directors' remuneration as originally intended, but, after some discussion on the point, the motion was not pressed, Mr. Herring giving notice that he would bring forward at the next meeting a resolution with the object in question.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY, LIMITED.

Directors: William Addison, Esq., chairman; B. St. John Ackers, Esq.; Henry Grëwing, Esq.; Thomas Lloyd, Esq.; George Bland Frost, Esq. Secretary: Alex. B. Chalmers, Esq.

Report of the directors for the period ended December 31, 1894, to be presented at the first annual general meeting of the Company, to be held at the Cannon-street Hotel, London, on Monday, April 29, at 1 p.m.

The shareholders will recollect that the Company was formed on March 12, 1894, to take over the property and assets of the old Oriental Telephone and Electric Company, Limited, the object in view being a rearrangement of the capital account of that company. In order to avoid any dislocation of the business and complexity of accounts, the latter have been continued as from December 31, 1893, the result being a net profit for the year of £8,729. 4s. 9d. As was intimated to the shareholders at the meeting held on March 12, 1894, a dividend on the present occasion can only be declared for the period from the date of incorporation of the Company to December 31, 1894. Under the advice of the auditors, therefore, the directors have apportioned £7,031. 4s. 6d. of the above sum as being the profit available for disposal. They propose to deal with this amount as follows: to write off £453. 17s. 10d., being the whole of the preliminary expenses incidental to the formation of the present Company, to pay a dividend at the rate of 4½ per cent. per annum, free of income tax, for the period from March 12 to December 31, which will absorb £5,871. 1s. 5d., and to carry forward £706. 5s. 3d. The general business of the Company has on the whole been satisfactory, and the electric lighting branch inaugurated by the old company shows prospects of assisting the revenue of the Company in the early future. The Bengal and Bombay Telephone Companies have paid improved dividends for the past year, whilst the Telephone Company of Egypt, the capital of which is almost entirely held by your Company, has made good progress. The accounts of the China and Japan Telephone Company have not yet been closed, but owing to the low rates of exchange ruling, the net revenue of that company, after payment of debenture interest, will show less favourably than in the previous year. Under Article No. 65 two directors retire at the present meeting, and these are Mr. William Addison and Mr. Thomas Lloyd, who, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., appointed by Article No. 89, also retire, and offer themselves for re-election.

REVENUE ACCOUNT YEAR ENDED DEC. 31, 1894.

Dr.	£	s.	d.
Expenses in London—Directors' fees	1,000	0	0
Salaries	831	16	0
Rent	100	0	0
Office expenses, including telephone subscription	117	5	0
Stationery, printing, etc.	43	5	3
Postages	14	13	4
Legal expenses	7	12	4
Audit fee	52	10	0
Income tax	152	4	8
	2,319	6	7
Indian agency expenses	712	18	11
Electric lighting branch	282	9	7
Balance transferred to profit and loss	8,729	4	9
	£12,043	19	10

Cr.	£	s.	d.
Net profit on working of the Company's exchanges to date, including dividends, etc., accrued from subsidiary companies	11,577	1	0
Sundry commissions, royalties, and interest	448	14	4
Transfer fees	18	4	6
	£12,043	19	10

PROFIT AND LOSS ACCOUNT TO DEC. 31, 1894.

Dr.	£	s.	d.
Preliminary expenses	453	17	10
Balance carried to balance-sheet	6,577	6	8
	£7,031	4	6

Cr.	£	s.	d.
Net profit for the year ended December 31	8,729	4	9
Less proportion of net profit for period from January 1 to March 12, 1894	1,698	0	3
	7,031	4	6
	£7,031	4	6

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Dr. BALANCE-SHEET, DEC. 31, 1894.	£	s.	d.
To capital authorised—200,000 shares of £1 each...	200,000	0	0
Capital issued—171,504 shares of £1 each fully paid	171,504	0	0
Sundry credit balances	1,187	17	1
Exchange revenue, 1895—subscriptions received for periods beyond December 31st, 1894	1,770	5	6
Profit and loss—balance	6,577	6	8
	£181,039	9	3

Cr.	£	s.	d.
Exchanges and goodwill	69,189	0	6
Shares, etc., held in subsidiary companies (valued at)	86,713	2	6
Stores in hand at branches and in transit	3,304	11	10
Office furniture	100	0	0
Consols (£13,004. 0s. 7d.—2¾ per cent.)	12,500	0	0
	171,806	14	10
Exchange revenue, 1895—subscriptions outstanding at December 31, 1894	79	7	2
Dividends accrued from subsidiary companies	6,689	5	8
Sundry debit balances	749	5	9
Cash at Parr's and Alliance Bank, current account, £1,039. 6s. 2d.; and in hand and with agents abroad, £675. 9s. 8d.	1,714	15	10
	£181,039	9	3

EASTERN EXTENSION TELEGRAPH COMPANY.

The report of the directors for the half-year ended December 31 last states that the gross receipts, including Government subsidies, have amounted during the half-year to £261,322, against £251,698 for the corresponding period of 1893. The working and other expenses, including £29,791 for cost of repairs to cables and expenses of ships, absorb £89,740, against £76,574 for the corresponding period of 1893, leaving a balance of £171,581. From this are deducted £4,584 for income tax, £31,895 for interest on debentures, debenture stock, and contribution to sinking fund, and £1,372 for celebrating the Company's twenty-fifth anniversary, leaving as the net profit for the half-year £133,729, which, with £68,457 brought forward from the previous half-year, shows an available balance of £202,186. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on the 2nd proximo, making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1894. The balance of £89,686 has been carried to the general reserve fund, which, after being credited with interest received during the half-year and profit on sale of investments, and debited with £100,000, part cost of the new Singapore-Hong Kong cable, now stands at £641,598. In accordance with the provisions of the trust deed dated May 10, 1879, 389 of the Company's 5 per cent. Australian Government subsidy debentures, amounting to £38,900, were drawn by lot on the 1st inst. for payment at par on July 1 next.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Huddersfield.—The Electric Lighting Committee of the Town Council invite tenders for 2in. and 3in. cast-iron spigot and socket pipes. We have already given particulars. Tenders must be sent in by to-day.

Manchester.—The Lancashire and Yorkshire Railway Company require by the 30th April tenders for the supply of an oil-engine, engine packing, signal and telegraph fittings, signal, telegraph and electric light wires, wire, etc.

Brighton.—The directors of the Brighton and Rottingdean Seashore Electric Tramroad Company are prepared to receive tenders for the supply and maintenance of accumulators for an output of 35 e.h.p, at about 200 volts, for use on a large car. Particulars upon application to Mr. Magnus Volk, Madeira-road, Brighton.

Londonderry.—The Corporation invite tenders for the supply of carbons for one year from June 1, 1895. Schedules of quantities and further particulars may be obtained on application to Mr. John Christie, electrical engineer, Strand, Londonderry. Tenders, accompanied with samples, marked "Tender for Carbons," to be lodged with Mr. R. Chambers, town clerk, not later than May 1.

Brighton.—Notice is given that the Council of the borough will receive tenders from such persons as may be willing to enter into a contract for the supply and erection of boilers at the Corporation electricity works. The Council also want tenders for the supply and erection of arc lamps, switches, etc., and, thirdly, for the supply of indiarubber lead-covered armoured cables. Specifications can be obtained on application at the town clerk's office, Town Hall, Brighton. Tenders for the boilers are to be sent in by May 13; for the arc lamps, switches, etc., by May 27; and for the indiarubber lead-covered armoured cables by May 13.

Portsmouth.—Tenders are invited for wiring and lighting by electricity (1) the Corporation stables, Landport, (2) the fire brigade station, Landport. Full particulars can be obtained and the specification in each case may be seen at the Town Hall, where form of tender for each division of the work can also be obtained. Forms of tender supplied are to be completely filled in and sent under cover to Mr. Alexander Hellard, town clerk, by 10 a.m. on 29th inst. The form of tender will comprise an agreement to pay not less than the trade union rate of wage and to observe the hours of labour and conditions recognised and in practice obtained by the trade unionists in the borough.

Rangoon.—Tenders will be received by the president of the Rangoon Municipal Committee, not later than November 4, for the lighting of Rangoon by electricity. Tenders should be accompanied by detailed plans, specifications, and estimates, and must state the terms on which the installation proposed will be undertaken. All information regarding the existing system of lighting and the cost, etc., with plan of the town, can be obtained on application to Messrs. Ogilvy, Gillanders, and Co., Sun-court, 67, Cornhill, London, E.C., accompanied by a remittance of £1. 1s. Tenders are to be sent in sealed covers and endorsed "Tender for Electric Lighting, Rangoon." Mr. J. Short, Rangoon, is the secretary of the committee.

Manchester.—The Corporation invite tenders for the supply, delivery, and erection, complete, of the electric lighting machinery and installation for the efficient lighting of the new foreign animals wharf, situated at Mode Wheel. Copies of general conditions, specification, and drawing can be obtained on application to Mr. T. de Courcy Meade, city surveyor, Town Hall, Manchester, on payment of five guineas (which will be returned on receipt of a *bonâ fide* tender). Tenders, to be endorsed "Tender for Electric Lighting, etc., Foreign Animals Wharf, Mode Wheel," to be addressed to the chairman of the Markets Committee, and delivered at the city surveyor's office not later than 9 a.m. on Monday, May 13. The Corporation do not bind themselves to accept the lowest or any tender.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—The receipts for the past week were £2,808.

Hayfield (Stockport).—The Parish Council want to know the comparative cost of gas and electric lighting.

Kingswood.—A committee of the Urban District Council are considering the question of the introduction of the electric light.

Croydon.—A new theatre—the Grand—has been built here. Provision has been made for the introduction of the electric light later on.

Removal.—Mr. C. A. Clarke (Messrs. Mix and Genest, Limited) informs us that his address is now 37, Marshall-place, Cheetham Hill, Manchester.

Eastern Extension, Australasia, and China Telegraph Company.—The ordinary general meeting will be held on May 1 at Winchester House, E.C.

Electricity for Gold Mines.—The Forbes Reef Gold Mining Company, Limited, notify that the electric power plant to work the Avalanche Mill has started, and works well.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 21st inst. amounted to £1,386, as compared with £682 in the corresponding week of last year.

West India and Panama Telegraph Company.—Dividends of 6s. per share on both the first and second preference shares are recommended by the Board for the six months ended December 31 last.

Cheshire Electric and Steam Yacht Company, Limited.—This Company has been registered, with a capital of £2,000, to carry on the business of a shipping company in all or any of its branches.

Hull.—A Local Government Board enquiry was to be held last night by Colonel C. H. Luard, R.E, into an application of the Corporation for sanction to borrow £2,800 for an extension of the electric lighting plant.

Eastern Telegraph Company, Limited.—This Company announce the payment by warrants on May 1 of interest for the half-year ended April 30 on its 4 per cent. mortgage debenture stock. The transfer books will be closed from April 26 to May 1, both days inclusive.

Keswick.—A meeting of the Urban District Council was held last week at which a letter was read from the electric light company suggesting a meeting with the Council to-day (Friday). Mr. Hope moved that the letter be referred back to the committee, and this was agreed to.

Alternate-Current Electromotor Syndicate, Limited.—This Company has been registered with a capital of £6,000 to enter into an agreement with W. L. Davies for the acquisition of certain patents relating to improvements in electromotors, and to develop and to turn to account the same.

City and South London Railway.—The receipts of the Company for the week ended April 21 were £856, against £886 for the corresponding week of 1894, or a decrease of £30. The total receipts for the current period of the present half-year are £15,219 against £14,613 in the corresponding period of 1894, an increase of £606.

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Perth.—The Police Commission have agreed to a recommendation of the water manager to light the waterworks with electricity at a cost of £80, with £12 annually for upkeep. The present gas bill amounts to £40 a year.

The City.—At Tuesday's meeting of the Commissioners of Sewers, the clerk read a letter from the comptroller (Mr. Brand) asking that Mr. Voysey, the electric light inspector, should be allowed to act as consulting electrical engineer to the Corporation at a nominal sum. The consideration of this matter was adjourned until the next court.

Stafford.—A meeting of the Town Council was held on Tuesday, when, in moving the adoption of the report of the Electric Lighting Committee, Mr. W. H. Peach said that the workmen would begin the laying of the cables in a few days, and that the committee were pleased with the way in which the tradesmen of the town were taking up the electric light.

Cheltenham.—As at present arranged, the formal handing over of the Corporation electric lighting station by the contractors, Messrs. Siemens Bros. and Co., will take place on Tuesday, 30th inst. Mr. Preece, F.R.S., has promised to take part in the ceremony, and it is also probable that Prof. Ayrton, Mr. Alexander Siemens, and Mr. Callender will also be present.

Liverpool.—The special committee appointed by the Corporation to negotiate with the Electric Light Supply Company in that city for the purchase of their undertaking as a going concern have practically arranged for its acquisition for £400,000. Before entering into a formal agreement, however, the committee have decided to obtain the services of an expert to examine the whole resources of the company.

Submarine Cables Trust.—The report of the trustees states that the accounts for the financial year to April 15, 1895, show that the revenue, including the balance of £240 brought from the previous accounts, amounted to £21,704. The expenses of the trust amounted to £1.194, and the payments on account of the coupons to £20,286, together £21,480, leaving a balance of £224 to be carried forward.

Belfast.—The Electric Light Committee of the Town Council have held a meeting under the chairmanship of Alderman Pirrie, J.P. The electrical engineer (Mr. M'Cowen) reported that some of the brass inspection plugs in the street boxes had been wantonly removed, either for mischief or for the value of the brass, and that the City Commissioner of Police had been requested to draw the attention of the constabulary to the matter with a view to the detection and punishment of offenders.

Barnsley.—A discussion has taken place in the Town Council as to what is to be done with the land in Kendray-street. Alderman Halton said that the Corporation had sold land in important thoroughfares before—notably the Three Cranes—and they must regret it now. Although he did not consider Kendray-street was the best site for municipal buildings, he thought that in the future when the town was supplied with electric light by the Corporation, this would be the centre for the electric light.

Greenwich.—The District Board of Works have received from the St. Paul, Deptford, Committee a report stating that they had considered a letter from the Vestry of St. Mary, Islington, who were of opinion that parliamentary powers should be obtained giving the Board of Trade or some other independent authority control over gas companies similar to that exercised over electric lighting companies. On the recommendation of the committee, it was resolved to inform the Board of Trade that the Greenwich District Board of Works concurred in the suggestion.

Cardiff.—At the Cardiff Council meeting on Monday, Councillor White drew attention to the minutes of the Lighting Committee, wherein it was stated that a discount of 25 per cent. should be allowed on the accounts for the electric light supplied to the Great Western Hotel in respect of lamps burning both day and night, and to similar discounts allowed to other consumers. The Mayor explained that the extra discount was given to encourage the use of electric light during the day. The discount might seem very heavy, but the interests of the town were protected.

Birmingham.—Mr. Frederick Herbert Tulloch, the inspector of the Local Government Board, held an official enquiry at the Guildhall, on Thursday last week, into the application of the City Council for sanction to borrow £20,230 for purposes of electric lighting. It was stated that the Local Government Board had already sanctioned the applications of the Council to borrow some £41,000. The further loan was required for additional work and extras, which were explained by the city surveyor. The proceedings were formal, and there was no opposition.

African Direct Telegraph Company.—Notice is given that, in conformity with the conditions upon which the issue of the 4 per cent. mortgage debentures was made, the fourth drawing for payment of these debentures, 115 in number, will take place in the presence of a notary public of the city of London, on Wednesday, May 1, at 3.30 p.m., at the offices of the Company, Winchester House, Old Broad-street, London E.C. Notice is also given that the second drawing for the 4 per cent. registered debentures (series B), 14 in number, will take place at the same time and place.

Wimbledon.—The Electric Light Committee of the Urban District Council have recommended that a fee of £50 be paid to Mr. Preece to prepare a plan for lighting the district by electricity. Mr. Neller suggested that Mr. Preece should be asked to also prepare an alternative plan for lighting the main thoroughfares only. There was a possibility that the cost of lighting the whole town by electricity would be more than the Council would be willing to bear. Mr. Crimp moved, and Mr. Crickmay seconded, that Mr. Preece first be asked to meet the whole Council in committee. This proposal was agreed to.

Great Northern Telegraph Company.—The total receipts during the year 1894, including the balance brought forward from 1893, have amounted to £386,438, and the expenses have been £78,962, which shows a net profit of £307,476. The following payments have been made: 5 per cent. interest on debentures, 1883 issue, £9,750; amortisation of 100 debentures, £10,000; amortisation fund, £27,777. The Board propose to place to reserve and renewal fund £83,333, to the pension fund of the staff £2,777, and to declare a final dividend, making, with interim dividends already paid, 8·60 per cent. for the year, carrying forward a balance of £43,170. 17s. 8d.

City of London Electric Lighting Company, Limited.—The revenue return of this Company for the quarter ended March, 1895, is as follow, the figures within brackets being those for the corresponding period of last year: revenue from sale of current for public lighting £3,191 (£3,100); revenue from sale of current for private lighting, etc. £26,622 (£12,460); estimated revenue from other sources £340 (£404); total, £30,153 (£15,964), being an increase of £14.189. The equivalent of 8 c.p. lamps connected on March 26. 1895, was 148,594, being an increase during the quarter of 13,134. The equivalent of 8-c.p. lamps connected on March 26, 1894, was 84,634, being an increase during the corresponding quarter of last year of 19,293.

Brighton.—At a meeting of the Lighting Committee of the Town Council held on April 8, the sub-committee appointed to consider the request of the Finance Committee for a contribution towards the cost of collection of rates in respect of the electricity charges reported that, having given the matter their full consideration, they were of opinion that a sum of £250 per annum should be paid from the electricity works account as a contribution towards the expenses of the rate collection, and recommended accordingly. The sub-committee also recommended that it be suggested to the Finance Committee that it was desirable that one collector should be permanently allotted for the collection of the electricity charges. The committee approved the report. On the motion of Councillor Stafford, these proceedings have been confirmed by the Town Council.

Luton.—A communication has been read at a meeting of the Town Council from Messrs. Sharpe, Parker, and Co., stating that a Bill to confirm the electric lighting provisional order was introduced into the House of Commons on April 4, and read a first time. A print of the Bill would be sent as soon as it came from the press. At the same meeting, with reference to the telephone wires, Mr. Wilkinson said it was necessary the public should be guarded against any dangers which might arise from the wires, and asked if it was possible for the Corporation to levy some kind of toll for the privilege of crossing the street, as that would enable them to exercise some control over the wires and test their stability if need be. The Mayor said the matter had not come before the General Purposes Committee, but doubtless when the town clerk returned he would take proper steps to protect their interests.

Folkestone.—The Town Council have received a long letter from the chairman of the directors of the Dover Electric Company, stating that the installation was now nearly complete and inviting the Corporation to inspect the works, promising to make arrangements for their reception and to afford every information as to the plant necessary to light Folkestone. The letter also intimated that the company could make arrangements to light Folkestone and give very advantageous terms. Alderman Sherwood remarked that there were three committees appointed. He suggested another, to which that letter should be referred. Councillor Thompson moved that the letter be received and that the invitation be accepted. It would be a very good thing, especially for Mr. Baker's committee, for as far as he could learn, they knew nothing yet about electricity. Councillor Tolputt seconded, and it was carried.

Great Northern and City Railway.—In connection with the private Bill of this Company there has been considered before Mr. Campion, one of the parliamentary examiners, a petition for an additional provision to the Great Northern and City Railway Extension of Time Bill. The petition stated that the Great Northern Company had decided to rearrange their Finsbury Park Station to enable the trains to run into that station instead of Drayton Park as originally proposed; and, as it was desirable that the same locomotive power should be used, power was asked to use steam as the motive power on the City line in addition to or in substitution of electricity, as at present authorised. The Metropolitan Railway Company objected that the standing orders had not been complied with, as the notices for the Bill did not include the substitution of steam as one of its objects, and the examiner upheld their contention, and reported that the standing orders had not been complied with. The question will subsequently be dealt with by the Standing Orders Committee.

Bath.—Alderman Sturges, at a meeting of the Surveying Committee, has brought up the electric light bill for the last quarter, amounting to £563, but £30 was deducted for fines, and Mr. Sturges moved that £10 be omitted from the fines owing to exceptional circumstances. The proposal to reduce the fines was carried. To the Town Council, sitting as the urban sanitary authority, Alderman Sturges has presented a report from the Lighting Committee with regard to the application of the electric lighting company for a provisional order and the counter-application of the Corporation. The alderman explained that the committee declined to accept the suggestion of the Government inspector, that the authority should consent to the company

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having the order upon condition that certain clauses were inserted in it giving the authority the power of purchase. After some discussion the following resolution was adopted: "After very carefully considering the report and deliberating upon the concluding suggestions contained in it, your committee are still unanimous in their desire to obtain a provisional order according to the decision of the authority on January 14 last."

Bournemouth.—A meeting of the Vestry of Holy Trinity Church has been held, at which the Vicar asked if General de Vitre could give them any information with regard to the cost of the electric light and the gas. General de Vitre cited two years by way of example with regard to gas. In the first of those two years the cost of the gas was £38. 4s. 5d.; in the next £39. 6s. 10d. Those amounts did not include the cost of repairs. The average cost of gas had been £38. 15s. The electric lighting had been supplemented to some extent by gas for heating the church. For example, during the first complete year in which they had the electric light the gas used cost £2. 16s. 3d., and in the following year £4. 1s. 10d. The electric light for that first year came to £34. 17s. 6d., and adding the £2. 16s 3d., the total was £37. 13s. 9d. In 1893-4 (which was the next year) the electric light bill was £26. 4s. 3d., and adding the £4. 1s. 10d., the total came to £30. 6s. 1d. Last year the total for electric light and gas was £32. 9s. 10d. The average cost per year for electric lighting, including also the gas used, was £35. 10s, so that the electric light bills, even including the gas used, had been less than the bills for gas lighting.

Aberdeen.—An extensive installation of the electric light has just been carried out in the police and municipal departments of the Town House. Altogether about 200 lamps are used, the power varying from 8-c.p. incandescent to 2,000-c.p. arc. The buildings have been divided into sections, so that each department may register its own consumption, and there is also a subdivision of sections by which it is made impossible, in the event of an accident, for the whole of the lights in a room to go out at one time. In the Town Hall the arrangement of the lamps has been carried out very effectively, 34 incandescents being placed on the ornamental bosses of the roof. Each lamp is of 25 c.p. The work has been carried out by Messrs. New and Mayne, electrical and general engineers, 6, Schoolhill. All the wires have been laid and the walls pierced without the slightest damage having been done to any of the decorative painting. It was no easy task to accomplish this so successfully. At some places the wires had to be taken through blocks of masonry about 5ft. or 6ft. thick, and in other places, to prevent the breaking of plaster, the wires had to be carried along very circuitous routes. In one case, indeed, about a quarter of a mile of wire was utilised in supplying a current to a bracket only a short distance from the street main.

Hammersmith.—The committee of the Vestry appointed to consider the question of electric lighting have reported having viewed various sites for a generating station, and recommended the Vestry to treat for the purchase of two pieces of land abutting upon Fulham Palace-road, known as the Gardens Estate, belonging to Miss Yeldham and the Latymer Foundation, for the sum of £7,000. Mr. Searle, as chairman, moved the adoption of the recommendation. He wished to thank Mr. Rawley Cross for his assistance in trying to select another site. Mr. Greig moved a reference back to the committee to consider a suggested site in Uxbridge-road. Mr. Glasier supported the committee's report, remarking that it was a great convenience to have the station near the wharf. The cartage of coal was a serious thought, and the nearer the wharf could be to the station the better. Mr. Payne advocated a more central station. He suggested that advertisements be issued calling for offers for the sale of land in different parts of the parish. Mr. Bendon thought the Vestry would be acting indiscreetly if they did not embrace the offer of Miss Yeldham and close the bargain. An amendment by Mr. Greig that the matter be referred back to the committee only received three votes, the other members voting for the recommendation, which, of course, was agreed to.

Pemberton.—The chairman of the District Council, at a meeting of that body, drew attention to the request of the Pemberton Electric Lighting Company for the permission of the Urban District Council to lay down and work plant for the supply of electric light to the whole or any portion of the Pemberton township. Mr. Clayton thought that by allowing the electric lighting company to step in the Council would be practically selling its birthright. The Chairman poiated out that they had power to buy them out. Mr. Clayton referred to mistakes the Pemberton Board had made in the past. One was that they allowed the gasworks to slip through their fingers, and the other that they fought the battle of the waterworks, whereby they lost something like £30,000. They ought to be very careful in the matter now before them ere they consented, in any shape or form. Mr. Cheetham thought when the present scheme was put before them that if they, as a Council, were not prepared to go on with it, let them try what private individuals would do. He moved that, subject to satisfactory conditions being arranged, the consent of the Council should be granted to the proposed Pemberton Electric Lighting Company, Limited, to light the whole or such portion of the district of Pemberton with electricity as the proposed company might think fit. The motion was carried. A committee was appointed to deal further with the matter.

Ford-Lloyd Manufacturing Company.—The affairs of this Company came before Mr. Justice Vaughan Williams on Wednesday. The action of Grove *v.* Ford-Lloyd Manufacturing Company, Limited, was a motion for judgment in the usual form against an electrical engineering company, in default of defence. The Court had granted a winding-up order, and the official receiver was not represented. Plaintiff was a holder of £1,000 debentures, in regard to which default had been made through non-payment of interest, etc. His Lordship made a compulsory order, and continued the official receiver as liquidator of the Company. The creditors and shareholders of the Company met at the Board of Trade offices, 33, Carey-street, when Mr. G. S. Barnes, official receiver, stated that the Company was formed in June, 1893, with a nominal capital of £10,000, to acquire the business of electrical engineers and manufacturers carried on by the Ford-Lloyd Manufacturing Company, with the sole right to dispose of the invention known as the "E. S. Dry Battery." The failure of the Company was attributed to the want of sufficient capital to work the business. The accounts filed showed unsecured debts, £977; liabilities on bills discounted, £927; loans on debenture bonds. £3,000; and preferential claims, £120. The assets, valued at £1,631, were fully charged to secure the loans on debentures. No liquidator was nominated, and the case was left in the hands of the official receiver.

Medical Electrical Institute.—The affairs of this concern have been up again in the Courts. This company was formed last October to take over the business hitherto carried on by the Medical Battery Company, Limited, which went into liquidation in November, 1893. The capital was agreed at £75,000, of which £50,000 ordinary shares were to be issued as fully paid to the shareholders of the old company, and £25,000 preference shares were to be issued to the creditors of that company. No shares had been allotted under that arrangement, the company being unable to carry through the reconstruction scheme to completion. First debentures to the amount of £2,790 had been issued, and others were to follow, forming a charge of £6,650 upon all the assets of the company. In January last a receiver was appointed on behalf of the debenture-holders, and recently a winding-up order was made against the company. At the meeting of creditors and contributories held before Mr. C. J. Stewart (official receiver) no resolution was moved for the appointment of a liquidator, and the matter was left in the hands of the chairman to be wound up in the usual manner. The accounts filed under the proceedings showed unsecured debts £1,363, other liabilities £648, loans on debenture bonds £9,440, and preferential claims £186. The assets are valued at £6,000, and are covered by the debenture bonds, the deficiency to the creditors being £5,680. In reply to a creditor, the chairman said there was no prospect of any dividend being paid on the unsecured claims, which included a sum of £250 in respect of directors' fees. Nothing whatever had been received by the directors.

Worcester.—The City Council having applied to the Local Government Board for sanction to a loan of £20,230 for purposes of electric lighting, an official enquiry as to the proposal has been held at the Guildhall by Mr. Frederick Herbert Tulloch. M I.C.E., Local Government Board inspector. The town clerk (Mr. S. Southall) represented the City Council, and there were also present Alderman T. Rowley Hill, Mr. G. H. Williamson (chairman of the Electricity Committee), Mr. W. H. Preece (consulting electrical engineer), Mr. F. R. Davenport (Mr. Preece's assistant), Mr. T. Caink (city engineer), Mr. Ruthven Murray (city electrical engineer), and Mr. F. George (city finance clerk). The Town Clerk explained that the Corporation applied for a loan for electric lighting purposes of £39,109 and that was sanctioned on August 5, 1893. That loan was intended to cover three items: purchase of land, £5,000; erection of generating station, £11,000; and generating plant and some mains in the city, £23,109. The City Council afterwards applied for a further loan of £1,861, which was sanctioned on July 2, 1894. That referred to street-lighting. As regarded the first loan, they had expended on the purchase of the land £5,060 instead of £5,000. They had to buy another small piece of land, exactly in front of the works, from Sir Harry Vernon, and another piece of land added to the mill pond, the two additional pieces costing £85. The land tax was redeemed, when practically the land was vacant, at a cost of £118. 11s. 6d. As regarded the generating station, the Council in the first place understood that the building would cost about £10,000, but the contract amounted to £14,797, leaving an excess over the loan of £11,000 applied for of £3.797. In reply to an enquiry from the inspector as to a number of extras in the plant at the generating station, Mr. Preece said they gained experience from other places as the work proceeded, and that accounted for many alterations and additions to the work contracted for. The Inspector enquired as to an item in the loan applied for of £500 for additional works by the Brush Company, and Mr. Preece explained that the items were for electrical instruments, protecting the machinery in accordance with the requirements of the Board of Trade, and other small extra works at the generating station. Mr. Preece stated that the final accounts between the Corporation and the Brush Company were not yet settled. He had examined them all and had certified some of them. The only item in dispute was £600, which would be settled by arbitration. The Inspector then enquired into the details of the expenditure for extensions of mains and other works making up the amount of the loan. The proceedings were formal and there was no opposition.

Hampstead.—The Vestry held a meeting last week at which the Lighting Committee recommended that the necessary mains, etc., be laid for the supply of electric current to private consumers in certain roads at a cost of £2.428. Mr. Thwaites, chairman of the committee, stated that 7,338 incandescent lamps had now been fixed by the Vestry's private customers. The revenue last quarter from this source was £770, an increase of £330 over the previous three months. The recommendation was adopted, as

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was the proposal that the plan showing an extension of the arc lighting in Finchley-road, from Swiss Cottage to Boundary-road, be adopted, at a cost of £175. It was decided that the plan submitted by the engineer for splitting up the network for electric lighting in the parish be carried out at an estimated cost of £300. The same committee reported that they had informed Mr. Preece, in reply to his letter, that the intention of the Vestry, by the resolution of March 14, was that their own engineer should prepare plans and estimates for, and superintend the carrying out of all extensions of, the electric lighting in the parish, but that in the event of any difficulty occurring they would be glad to have his (Mr. Preece's) opinion and advice, upon such terms as should be mutually agreed upon. Mr. Hall moved that the resignation of Mr. Chattock be accepted, and that he be congratulated upon having received a better appointment. This was carried. A fortnight ago the Vestry resolved that the Willesden District Council should be informed that the estimated cost of laying down the necessary mains, with lamp standards and fittings for 24 arc lamps in the High-road, Kilburn, was £1,460, and that the cost of running these arc lamps at the present cost price would be £41 per lamp per annum; also, that the Willesden District Council should be asked if, in the event of the Vestry agreeing to light the High-road, Kilburn, by electricity, they would be willing to pay half of the said estimated cost, and half the cost for the time being of running the said arc lamps. A reply was now received from the Willesden District Council, intimating that, in view of the large outlay and annual expenditure, the Council could not agree to pay half the present estimated cost of such lighting. A letter was received from the London and Hampstead Battery Company, referring to the proposal of the Vestry to carry their electric lighting mains to Kilburn for the supply of the shops and streets of that portion of the parish, and suggesting that some scheme might be employed for the mutual advantage of the Vestry and the company, the latter being of opinion that there was plenty of work for both to do. They stated that they would be willing to transfer to the Vestry all the work which they held on the north side of Finchley-road if the Vestry would transfer to them that portion of their provisional order which covered the portion of the parish south of that road. The letter was referred to the Lighting Committee.

PROVISIONAL PATENTS, 1895.

April 16.

7584. **Improvements in methods of electric distribution.** John Hall Rider and John Pilling, Corporation Electricity Works, Bolton.

7600. **Improvements in and relating to primary batteries.** Walter Rowbotham, Hymen Levetus, and Sarah Isabelle Levetus, 47, Victoria-street, Birmingham.

7625. **Improvements in electric wire insulators.** Daniel M. Rothenberger, Charles A Inglis, and Edward D. Reilly, 46, Lincoln's-inn-fields, London. (Complete specification.)

7649. **Improvements in and relating to electric arc lamps.** Edward Harold Crosby and Otis Madison Shaw, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.

7657. **Improvements in secondary or storage batteries.** William More McDougall, Henry Burr Adams, and George Putnam Smith, 115, Cannon-street, London. (Complete specification.)

7668. **Improvements in systems of electric distribution.** James Devonshire, 24, Southampton-buildings, Chancery-lane, London. (Edwin W. Rice, United States.) (Complete specification.)

April 17.

7703. **An improved electric bell switch and burglar alarm.** George Frederic Lewis Alexander, 69, Lordship-road, Stoke Newington, London.

7705. **Improvements in the construction of holders for electric glow lamps.** William McKenzie and John Ambrose Fleming, the Electrical Laboratories, University College, Gower-street, London.

7712. **Electric bath metal-heating apparatus for metals and ores.** George Dexter Burton, 52, Chancery-lane, London. (Complete specification.)

7713. **Electric bath metal-heating apparatus.** George Dexter Burton, 52, Chancery-lane, London. (Complete specification.)

7714. **Improvements in connection with incandescent mantles.** William Crookes, 55, Chancery-lane, London.

7735. **An improved electromotor.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Antonietta Della Casa, Italy.)

April 18.

7773. **Improvements in or connected with the production of electricity.** Harry Tee, 50, Castle-street, Liverpool.

7782. **Improvements in electric resistances.** Julius Ferdinand Heinrich Voigt and Jacob Adolf Haeffner, 6, Lord-street, Liverpool.

7785. **Improvements in connection with ventilating electric culverts, test-boxes, and other street-boxes.** Thomas Harden, 11, Durham-road, Wimbledon, London.

7788. **Improvements relating to electric arc lamps.** William Reginald Ridings, George Frederick Bull, and Llewellyn Burbank Codd, 124, Chancery-lane, London.

7795. **Improved construction of electrical accumulators.** Vicomte Gaston de Schrynmakers de Dormael, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

April 19.

7829. **Improvements in the method of and means for charging electric storage cells.** William Joseph Starkey Barber-Starkey, 70, Market-street, Manchester.

7837. **An improved apparatus for electrically heating liquids.** Paul Stotz and Friedrich Wilhelm Schindler-Jenny, 89, Chancery-lane, London.

7888. **Improvements in electric cells or batteries.** Eugène Etève, 4, South-street, Finsbury, London.

April 20.

7910. **Improvements in and connected with apparatus for lighting up roundabouts and the like by electricity.** Frederick John Borland, 8, Quality-court, Chancery-lane, London.

7930. **Improvements in laying electric conductors underground.** Joseph Alexander Jeckell, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1891.

9762. **Storage batteries.** Currie. (Second edition.)

1893.

5198. **Electrolytic apparatus.** Hargreaves and Bird. (Second edition.)

1894.

8224. **Electric lighting.** Aldridge.

10172. **Electric rail or tram vehicles.** Hopkinson.

10332. **Arc lamps.** Suter.

10426. **Dynamo-electric machines.** Kingdon.

25289. **Primary battery.** Ludvigsen.

1895.

2918. **Dynamo-electric machines.** Devonshire. (Steinmetz).

4106. **Dynamo-electric generators and motors.** Lones.

4153. **Insulating electric conductors.** Johnson. (Downes.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5⅜
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅜-2⅝
—— Nom. Cum., 6 per cent. Pref.	2	2⅜-2½
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5-5⅛
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	15-15½
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	130-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	100 105
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1⅛-1⅜
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1⅛-1⅜
Elmore's French Company	2	—
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	⅛-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	9½-10⅛
—— Preference	—	12
House-to-House Company, Ordinary	5	3⅛-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge	5	7-7⅛
—— 6 per cent. Pref.	5	7-7⅛
Liverpool Electric Supply, Ordinary	5	7 11/16-7 13/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8⅜-8⅝
—— Pref.	10	14-14½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric	5	⅛-¼
Metropolitan Electric Supply	10	10-10½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5⅛ 5⅜
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅛-6
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7⅛-7⅞
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5⅞-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅛-8
—— 7 per cent. Pref.	5	8⅛-9
Swan United	—	—
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	106-108
Westminster Electric Supply, Ordinary	5	7⅛-8
Yorkshire House-to-House	5	5⅛-5⅜

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NOTES.

Navy Search-Lights.—The search-light has been put into practical use by those vessels of our Navy which have been concerned in the occupation of Corinto, Venezuela.

New Edition.—Messrs. Whittaker and Co., of Paternoster-square, E.C., are about to issue a second and greatly enlarged edition of "First Book of Electricity and Magnetism," by Mr. W. Perren Maycock, M.I.E.E.

Is the Profit too Great?—Some anonymous letters have appeared as to whether it is right that the St. Pancras electric light station should show a profit. The argument is that the consumers, being ratepayers and proprietors of the plant, should get current at cost price.

Private Bill Legislation.—The London County Council Money Bill has passed the Examiners on Standing Orders of the House of Commons. The Bill provides, among other things, for the electric lighting of Victoria-embankment and Waterloo and Westminster Bridges at a cost of £21,000.

Institution of Electrical Engineers.—The next meeting will be held at the rooms of the Society of Arts, John-street, Adelphi, on Thursday, May 9, 1895, at 8 p.m., when a paper will be read "On the Recent Development of the Single-Acting High-Speed Engine for Central-Station Work," by Mr. Mark H. Robinson, member.

Electric Traction in Portugal.—It is announced that the French Thomson-Houston Company have arranged to build an electric tramway at Oporto, its length to be about two miles. The installation will comprise a 150-h.p. steam-engine, a 100-kilowatt dynamo, and three cars, each with two 25-h.p. motors. A number of German firms also tendered for the work.

Personal.—Mr. W. Elsdon-Dew, who has been for two years manager and resident engineer of the Kelvinside Electricity Company's supply station, Glasgow, has been appointed resident electrical engineer to the Transvaal Gold Exploration and Land Company, and leaves immediately to take charge of the electrical plant to be placed at their mines in the Transvaal.

Steam-Engines (Persons in Charge) Bill.—It has been agreed that the committee on this Bill consist of 17 members—viz., Mr. Allan, Mr. Brunner, Mr. Fenwick, Colonel Gourley, Mr. Hardy, Mr. Heath, Sir A. Hickman, Sir E. Hill, Sir B. Hingley, Sir J. Joicey, Sir S. King, Mr. Wilson Lloyd, Mr. Paulton, Mr. Renshaw, Mr. John Wilson (Durham), Mr. Woods, and Mr. Wrightson.

American Institute of Electrical Engineers.—We have received the April issue of the *Transactions* of this institute, containing, among other matter, the papers read by Messrs. E. P. Houston and A. E. Kennelly on "Resonance in Alternating-Current Lines," and by Prof. W. A. Anthony on "Underwriters' Rules." An obituary notice and portrait are given of the late Mr. George M. Phelps, the treasurer of the institute.

Foremen Engineers and Draughtsmen. — The members of the London Association of Foremen Engineers and Draughtsmen held their annual dinner at the Cannon-street Hotel on Saturday evening, the chair being occupied by Dr. Anderson, Director-General of Ordnance Factories. Among the toasts was that of "The Engineering Employers," proposed by Mr. W. T. Coates, and acknowledged by Mr. A. Siemens and Mr. Liddell Simpson.

Sanitary Inspectors' Association.—The following are the arrangements of this association for May: May 3—Sanitary Inspectors' Association deputation to Local Government Board on examination question; May 4—paper by Mr. J. Young on "The Dwelling-house from a Sanitary Point of View," Carpenters' Hall; May 51, June 1—visit of the association to Worthing on the invitation of Mayor and Corporation.

"Electrocution."—Dr. J. Mount Bleyer, who has been experimenting in connection with what he styles "acts of electrification," more generally known by the badly-constructed name of "electrocution," has come to the conclusion that death is due to "dynamic apoplexy." This is based on examinations of animals which have been killed by electricity, and also on the results of a post-mortem of a criminal who was this year executed at Sing-Sing.

Electric Lighting in France.—The Edison Company, which supplied current to portions of Lille, have passed over their contracts with their customers to the local Société d'Eclairage Electrique.—The Compagnie Electrique du Secteur Gauche, Paris, have received authority for an extension of their mains.—The Compagnie Electrique de la Banlieue-Ouest, of Paris, have been granted the monopoly for the electric lighting of the town of St. Cloud.

Electric Target.—The *Oesterreichische Militär Zeitung* states that experiments have been conducted at the military ranges at Graz, Austria, with an electric indicating target which has been invented by Colonel Felix Mauthner, of the 47th Infantry Regiment, and Mr. Fritz Figlovsky, an engineer. It dispenses with the services of markers, the target upon being struck showing approximately the part which has been hit both by signal and by means of a visible indicator.

Institution of Engineers and Shipbuilders in Scotland.—The annual general meeting of the thirty-eighth session of this institution was held in Glasgow last week, when the treasurer's annual financial statement was submitted and the award of medals and premiums for papers read in session 1893-94 made. A discussion also took place on a paper by Mr. W. Carlile Wallace, entitled "Electrical Transmission of Power in Shipyards and on Board Merchant Steamers."

Temperature of Incandescent Filaments.—Prof. Weber has lately given the results of a number of experiments made by him to determine the temperatures of filaments in electric incandescent lamps. He has found that the normal temperatures of all species of incandescent lamps is approximately the same, and is comprised between 1,565deg. and 1,588deg. C. In the case of some lamps giving a very brilliant light—that is to say, with very thick filaments—the temperature is 40deg. higher.

Rail Bonding.—Mr. George P. Low, in the *Transactions* of the American Institute of Electrical Engineers, concludes that the art of rail bonding now appears to have been perfected, and the damage that has been caused by corrosive electrolysis may be attributed to defective bonding, for without doubt proper main-to-track, rail-to-rail, and track-to-dynamo bonding will cure the ill almost without exception. The problem of eliminating electrolytic corrosion is, in brief, simply one of judicious bonding.

"The New Street Danger."—This is a stereotyped heading which the *Lancet* has adopted, that medical organ having of late made a sort of hobby of dealing with Major Cardew's reports, which can hardly be expected to be interesting to a physician as such. The latest conclusion which our contemporary has arrived at is that the gas companies (as well as the electric light companies) should take precautionary measures. The electric light companies are doing so, but the gas companies do not trouble themselves much. Neither are they likely to do so, unless obliged.

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Society of Arts.—The arrangements for next week are as follow: May 6, at 8 p.m., Cantor lectures, "Recent American Methods and Appliances Employed in the Metallurgy of Copper, Lead, Gold, and Silver," by Mr. James Douglas—Lecture III., "The Metallurgy of Copper"; May 7, at 4 p.m., Applied Art Section, "Recent Improvements in Designing, Colouring, and the Manufacture of British Silks," by Mr. Thomas Wardle; and May 8, at 8 p.m., twentieth ordinary meeting, "The Extraction of the Rarer Metals from their Oxides," by Prof. William Chandler Roberts-Austen, C.B., F.R.S.

Visits to Electric Light Stations.—The Home Counties District meeting of the Incorporated Society of Municipal and County Engineers will be held at Brighton to-morrow (Saturday), when among the visits to be made will be one to the central electric light station in North-road, and Mr. Arthur Wright, the electrical engineer and manager of the Corporation station, will read a paper on "Points of Interest in the Development of Electricity Supply at Brighton." The South Wales District meeting of the association will be held at Cardiff on Saturday, May 11, when the Cardiff electric light station will be visited among other works.

Electric Lighting Plant.—We have received from Mr. Charles A. Müller, 6, Mornington-villas, Bradford, an album of the central stations which have been fitted up by Messrs. Schuckert and Co., of Nuremberg. It is admirably got up. Brief particulars are given of the stations, together with photo-lithographic illustrations. The stations dealt with comprise Lübeck, Barmen, Hamburg, Bergzabern, Hanover, Düsseldorf, Berchtesgaden, Wachenheim, Altona, Christiania, Neuhaldensleben, Penzig, Aix-la-Chapelle, Budapest, Sigmaringen, Haardt, Munich, Zwickau, Steyr, Baden (Vienna), Pforzheim, Salzungen, Donaueschingen, and Copitz, and electric tramways at Zwickau and Baden (Vienna).

Curious Wiring Arrangements.—Mr. Thaddeus, the portrait painter, has raised an action against the liquidator of the Liberator Building Society for damages. It was stated that workmen in the employ of defendant spilled water on a floor in Whitehall Court, and that it ran through a hole in the ceiling through which the electric light wires passed and spoiled some drawings under the electrolier. The marvellous assertion was also made that water was found inside the bulb of an incandescent lamp. The case did not turn upon the wiring arrangements, nor, in fact, on anything connected with the electric light, so that the judges had not to deal with the interesting question of the water entering the lamp.

The Carbonelle Microphone.—Mr. J. Banneaux, the head of the Belgian Telegraph Administration, discussing the question of tests carried on recently over one of the Anglo-Belgian cables with the carbonelle microphone, says that it consists chiefly of two carbon discs with carbon granules between them. The characteristic feature of the instrument is its extremely high resistance, amounting to several million ohms. Its resistance varies also within wide limits. A common or centralised source of electrical energy is employed for a large number of transmitters. Mr. Banneaux considers that the tests have not proved the superiority of the carbonelle system over transmitters such as the Hunnings, Grünewald, etc.

Heat-Engines.—Last night (Thursday) Prof. W. C. Unwin delivered at the Institution of Civil Engineers the "James Forrest" lecture, his subject being "The Development of the Experimental Study of Heat-Engines." Among the different points dealt with were tests of steam-engines in Cornwall, experiments on boilers, trials of Welsh and North Country coal, the Mulhouse trials of 1859, the Dasymeter, experiments on steam-engines, Isherwood's experiments on marine engines, the physical properties of steam (Regnault), the foundation of thermodynamics (Carnot and Joule), the founders of the rational theory (Rankine, Clausius, Zeuner), the experimental theory, the conflict of the rational and experimental theories (Zeuner, Hirn, and Hallauer), and recent experiments (Willans).

A 67-Ton Electric Locomotive.—The Baldwin Locomotive Works have completed a 67-ton electric locomotive from designs by Messrs. Sprague, Duncan, and Hutchinson. It is intended for special experimental work in handling heavy freights, and for shunting. The motors, four in number, and alternating in position, are of the "Continental" iron-clad type, the field magnets consisting of two steel castings, having two field coils placed at the ends of the motors, thus forming two consequent and two salient poles. The magnets are compound wound, and the armatures are of the slotted type. The motors are wound for 800 volts at 225 revolutions, which equal about 35 miles an hour when in multiple. About 250 amperes of current will be used, and at 93 per cent. efficiency each motor will give about 250 h.p.

Society of Engineers.—The next ordinary meeting of this society will be held at the Westminster Palace Hotel on Monday at 7.30 p.m. A paper will be read on "Street Subways for Large Towns," by Mr. Charles Mason, A.M.I.C.E., surveyor to the Vestry of St. Martin-in-the-Fields, of which the following is a synopsis: Introduction—Necessity for subways — Present underground arrangements unsatisfactory—Interferences with street surfaces—No recognised system for laying pipes—Acts of Parliament—Companies present powers—By-laws—Companies' objections thereto—Municipalities losing control of the streets — Early subways — London subways — Provincial subways — Difficulties of construction — The author's proposals — Points for consideration in designing a subway—Cost of construction—Revenue—Subways in old streets—Inspection and supervision—Municipal control—Conclusion.

British Patents.—In reply to Mr. A. C. Morton in the House of Commons, Mr. Bryce said that printed weekly and annual indexes of all British patents were regularly supplied to libraries in the cities of London, Manchester, Leeds, Glasgow, and Dublin, and also to 31 other business centres. It was well known that the grant of a patent carried with it no guarantee of validity. Mr. Bryce also said that he was aware that the average lifetime of a patent in this country was about five years. In 1893 and 1894 it was about four years and eight months. The number of patents which lapsed in 1893 was 9,302; and in 1894, 9,925. The Board had no power to instruct members of the profession of patent agents to make any statement on the subject. He believed that, as a rule, inventors were aware that the life of a patent depended on the payment of renewal fees. There was a statement to this effect on every patent issued.

The Proposed Pacific Cable.—The correspondent of the *Times* at Ottawa, telegraphing on May 1, says: "Information received here indicates that there is no possibility of securing a station for the proposed Pacific cable in the Hawaiian Archipelago. The advocates of an entirely British route will not regret this, as they prefer that Fanning Island should be selected. The Imperial Government is being urged to summon a conference of the colonies concerned to arrange the details of the construction of the cable." From Melbourne, on the same date, a *Times* correspondent telegraphed: "Mr. Larke, the delegate of the Canadian Government, has proposed to the Sydney Chamber of Commerce a scheme for the laying of a Pacific cable by Great Britain, Canada, and Australia. The cost would be £1,600,000, which would be borrowed at 2½ per cent.

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interest. It is estimated that half the present business at 2s. a word would repay the capital in 25 years besides the annual expenses."

Electric Lighting in Germany.—The Allgemeine Elektricitäts-Gesellschaft has been authorised to erect a central station for the supply of current to Magdeburg.—At Aix-la-Chapelle the street electric lighting is to be extended.—The private installation at the central railway station at Nuremberg is to be extended in the course of the summer, and a steam-engine of 120 h.p. will be added, bringing up the total horse-power to 400.—The Carolinenthal Municipality have instructed Mr. Krizik to prepare plans for a municipal central station for the distribution of current both for lighting and power purposes.—The proposal to establish a central station at Schneimühl has been shelved for the present.—In view of the increasing business at Cologne harbour, it has been decided to light the wharves electrically.—At Plauen a central station is to be erected by private enterprise.—An order has been given for a fourth alternating-current steam dynamo of 150 h.p. for the Frankfort-on-the-Maine station, so that by the arrival of winter 3,000 h.p. will be available.

Electrical Resistance.—A paper on the electrical resistance of certain poor conductors, such as wood and stone, by Mr. B. O. Pierce, appears in the *Proceedings* of the American Academy. He has examined numerous kinds of woods and stones under different conditions as to dryness. The author has also tried the effect of soaking the different materials in hot melted paraffin, and finds in every case, especially if the specimen has been previously well dried, that such treatment not only increases the specific resistance, but prevents change of resistance by absorption of moisture. The following are some of the results for the specific resistance obtained in megohms—the first number denotes in each case the lowest value observed, and the second number the mean value: mahogany 310, 610; hard pine 17, 1,050; white pine 360, 1,470; vulcanised fibre 3, 60; slate 184, 280; white marble 2,000, 8,800. The samples of wood were all well seasoned, and the resistance was measured in the direction of the grain, the resistance across the grain being generally from 20 to 50 per cent. higher. The samples of stone were dried in the sun for about three weeks before being tested.

The Pellat Electric Siren.—M. Pellat introduced his electric siren to a recent meeting of the Société de Physique, of Paris. The instrument differs from the siren of Cagniard de la Tour in the two following respects: (1) the holes of the plates have a direction corresponding to the latter; (2) the rotation of the disc is obtained by an electric motor. For this purpose, on the axis of the revolving disc a small Gramme ring is placed within an electromagnet. Current is supplied by three accumulators. No supplementary resistance is introduced into the inductor circuit, but auxiliary resistances are placed in the ring circuit by means of a continuous rheostat. The speed of rotation can therefore be varied at will, and very quickly be brought to a fixed value. Among other advantages, M. Pellat claims for his instrument that it is capable of producing both powerful low and weak sharp notes, which the Cagniard de la Tour siren cannot do; and that the flat sounds are as pure as the sharp, which is not the case with an ordinary siren. When M. Pellat had concluded his demonstration, M. Arnoux remarked that doubtless more fixity in the intensity of the sound would be obtained by the addition on the axis of rotation of a disc of copper revolving in a magnetic field.

A Sensitive Galvanometer.—In the course of researches on magnetism by the ballistic method, M. Pierre Weiss has been led to modify the usual type of Thomson astatic galvanometer, with the view of increasing its sensitiveness and the accuracy of its indications. He has constructed two instruments. In the first the total weight of the movable system is 0·47 gramme; the magnetic circuit is double, and composed of two systems of two magnetised needles 0·6mm. in diameter and 36mm. in length, the axes of which are 2·6mm. apart, fastened upon each of the faces of a thin sheet of mica, which has below the bobbins a concave mirror of 3·75mm. radius and of one square centimetre surface, weighing 0·1 gramme. The bobbins, made of 0·22mm. wire, have a total resistance of 146 ohms; their outside and inside diameters are respectively 27mm. and 9mm. The second galvanometer is smaller than the first in the proportion of 9 to 5 in general dimensions. The two steel needles are 0·2mm. in diameter and 18mm. long, and their distance apart is 1·2mm. The mirror weighs eight milligrammes, and is of rectangular form extended in the direction of the axis, which renders its momentum very small.

Predetermination of the Fall of Tension in Transformers.—A paper with this title has been given by Mr. Gisbert Kapp before the Elektrotechnischer Verein at a Berlin meeting. He stated that the determination of the fall of tension by direct measurements, particularly in the case of large transformers, has its difficulties. In the first place, considerable motive power must be available; secondly, a resistance or other apparatus was required which was capable of taking up a great amount of energy; and, thirdly, it was essential to know the phase-retardation in the secondary-current circuit. If all these conditions were fulfilled, the direct measurement certainly gives the fall of tension for this phase-retardation, but not for other values of the same. Such an experiment, therefore, did not perfectly disclose the behaviour of the transformers in respect of fall of tension. The method which he described and illustrated in detail rendered it possible, on the basis of a very simple experiment which required little motive power, and in which no resistances or energy-absorbing apparatus are necessary, to calculate beforehand the fall of tension for any load and for any positive or negative phase-retardation. Herr Dolivo-Dobrowolsky, in the discussion which followed the reading of the paper, stated that, in his opinion, the method expounded by Mr. Kapp was both very neat and very practical.

Electro-Chemistry.—M. Andréoli takes exception in the *Electricien* (April 20), to some of the statements concerning the electro-chemical industry which M. Lucion made at a recent meeting of the Société des Electriciens Belges. He ridicules that gentleman's assertion that the importance of E.M.F. in electrolysis has been over-rated. He asks if he is certain that the Société Elmore really manufactures 200 tons of tubes weekly. Chlorine does not whiten organic matter, as M. Lucion says anent the Hermite process. Platinum does not resist nascent chlorine, but it is not attacked in a solution of hypochlorite. M. Andréoli is also curious to know where the Knoepfer and Lebauer electrolytic system works satisfactorily, in which a solution of from 5 to 10 per cent. of chloride of sodium is used; and he says there is nothing practical in Lucion's long digression on the ampere-hour, which produces 1·33 gramme of chlorine. Everything depends on the way in which the vat is constructed, the electrodes are disposed, and on the diaphragm. Happy the man who produces one gramme of chlorine in continuous working! The Kelner mercury process, again, has no industrial existence. The Groth electric tanning works at Orbes, in Switzerland, has been abandoned. All, moreover, that Beketoff did, with respect to the electrolysis of

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chloride of sodium by the dry method, was to read a paper 10 years ago in a technical institute, in which he recounted what he had done with some Bunsen piles as the source of electricity. The refining of lead by the Keith process, M. Andréoli avers, was abandoned a dozen years ago, as has also been the Mœbius process; and the extraction of aluminium by the Montgelas method was never adopted.

Electricity in Agriculture.—Mr. Brettschneider, of Hoppenrade, Mecklenburg, has contributed to the *Landwirthschaftlichen Annalen des Mecklenburgischen Patriotischen Vereins* an account of the electrical installation on his land. The water power of the Nebel is utilised for driving a turbine, a weir having been constructed across the river. The amount of water available varies with the season, and from 16 h.p. to 22 h.p. is obtained from the turbine, which drives a Schuckert dynamo. Current is taken by different overhead conductors to the mansion, farm buildings, stables, barns, and garden for lighting and power purposes from a switchboard in the turbine-house, where there is also a 66-cell battery of accumulators. The accumulators are charged during the daytime. There are 100 incandescent lamps in the house and 92 elsewhere, in addition to two arc lamps. On the farm there are two electromotors of 10 h.p. and 2½ h.p. respectively The smaller motor is fixed, and drives the pumps for supplying water to the cattle, a chaff-cutter, a bandsaw, a lathe, and a grindstone. The larger motor is portable, and can be taken to the various barns as required, a short branch conductor being attached. Mr. Brettschneider calculates that in the year he uses 120,000 lamp-hours, or an equivalent of 12,000 horse-power hours for lighting, and the equivalent of 22,000 horse-power hours for power purposes, making a total of 34,000 horse-power hours. The cost per annum for this, including wages of an attendant, is £300. The cost for lighting is ·17d. per lamp hour. The author goes into details of his expenditure before he laid down the plant, and finds that he has effected a considerable saving by the new method, besides there being many advantages obtained from the use of the electric light and electromotors.

Electric Passenger Launches at Bergen.—The town of Bergen is built on each side of its busy harbour, a deep inlet of the sea, and until last year the inhabitants had no other means of crossing from one side of the port to the other beyond those furnished by ordinary rowing-boats. Then, however, the increasing commerce and population of the town rendered some quicker means of marine locomotion necessary, and eight electric launches were put on the water, by the Bergens Elektriske Faergeselskab, of the following dimensions: length, eight metres; greatest width, two metres; depth, 0·8 metre; displacement, six tons; passenger capacity, 18. In order to avoid turning when leaving the landing-stage the boats are built bow and stern alike, and furnished with two screws and two rudders. The screws are fixed on a common shaft, which is coupled direct to the series motor, which is placed under the floor in the middle of the launch, weighs 6cwt., is of 3 h.p., and is so constructed that the electric insulation cannot be affected by bilge-water. The accumulators are partly under the seats. The plates are those of the Akkumulatorenfabrik Aktiengesellschaft Hagen-i.-W.; they weigh 28cwt., and have an efficiency of 20,000 watt-hours. The average speed, with a consumption of 2,300 watts, is 2·25 metres per second, which is found to be sufficient in view of the crowded state of of the harbour. The bearings of the motor and the shaft are furnished with self-lubricators, so that the one man who attends to the boat may devote his whole attention to driving and steering it. Each boat runs about 40 English miles a day, and has its accumulators charged during the night, when also cleaning and any necessary repairs are effected. The total cost of the undertaking was £4,500—namely, £2,500 for the eight boats, including spare parts, and £2,000 for the charging station, mooring-place, and landing-stages. The service has so far given every satisfaction.

Royal Institution.—The annual meeting of the members of the Royal Institution of Great Britain was held on Wednesday at the house of the institution in Albemarle-street, Sir James Crichton-Browne presiding. The annual report of the committee of visitors for the year 1894, testifying to the continued prosperity and efficient management of the institution, was read and adopted. The real and funded property now amounts to above £102,000, entirely derived from the contributions and donations of the members, and of others appreciating the value of the work of the institution. Sixty-two new members were elected in 1894, and 63 lectures and 19 evening discourses were delivered in 1894. The books and pamphlets presented in 1894 amounted to about 242 volumes, making, with 578 volumes purchased by the managers, a total of 820 volumes added to the library during the year. Thanks were voted to the president, treasurer, and the honorary secretary, to the committees of managers and visitors, and to the professors for their valuable services to the institution during the past year. The following gentlemen were unanimously elected as officers for the ensuing year: president, the Duke of Northumberland, K.G.; treasurer, Sir James Crichton-Browne; secretary, Sir Frederick Bramwell; managers, Sir Frederick Abel, K.C.B., Captain W. de W. Abney, C.B., Lord Amherst, Mr. William Anderson, Sir Benjamin Baker, Messrs. John Birkett, William Crookes, Edward Frankland, Charles Hawksley, John Hopkinson, Alfred Bray Kempe, George Matthey, the Marquis of Salisbury, Messrs. Joseph William Swan, Basil Woodd Smith; visitors: Messrs. John Wolfe Barry, C.B., Charles Edward Beevor, M.D., Arthur Carpmael, Carl Haag, Victor Horsley, Hugh Leonard, Sir Joseph Lister, Bart., M.D., Messrs. Lachlan Mackintosh Rate, Alfred Gordon Salamon, Felix Semon, M.D., Henry Virtue Tebbs, Silvanus P. Thompson, John Westlake, Q.C., his Honour Judge Frederick Meadows White, Q.C., and Sir William H. White, K.C.B.

City and Guilds of London Institute. — The annual general meeting of the City and Guilds of London Institute for the Advancement of Technical Education was held on Monday at Mercers' Hall, Cheapside. Mr. E. L. Beckwith (treasurer) presided, in the absence of the Earl of Selborne, through illness. There were present, among others, Sir Frederick Abel (chairman of the executive committee), Sir Walter S. Prideaux, Alderman Sir Stuart Knill, Sir Owen Roberts, Mr. Ralph C. Palmer, Mr. T. F. Blackwell (Master of the Salters' Company), Prof. W. C. Unwin, F.R.S. (Dean of the Central Technical College), Sir Philip Magnus (superintendent of technological examinations), General J. W. Laurie, Dr. Spence Watson, Mr. J. J. Cooper Wyld, the Master of the Mercers' Company, the Master of the Clothworkers' Company, and Mr. Arthur L. Soper (assistant secretary). The Chairman, in moving the adoption of the report, referred with regret to the absence of Lord Selborne and to the letter which Mr. Watney had read from him. Commenting upon the various sections of the report, particulars of which we gave last week, he said that on the whole very satisfactory progress had been made during the past year. The Corporation and the City companies had again given their aid, and the institute, among other gifts, had received from the Siemens Memorial Fund a sum which would be very acceptable to

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the recipients of the Siemens medal. They were doing a very useful work in their own colleges and also in connection with other institutes and polytechnics upon whose governing bodies they had representatives. Sir Frederick Abel seconded the motion, and spoke of the value of that department of the work of the institute which gave instruction in the application of science to practical purposes. He also referred to the excellent work done by the technological examinations department. The report was agreed to. Mr. Beckwith and the other officers having been re-elected, the proceedings terminated. At a council meeting which was afterwards held the Earl of Selborne was re-elected chairman for the ensuing year.

Electric Pacemaker.—A novel application of electric power supplied by the San Jose and Santa Clara Railroad Company, U.S.A., is under consideration. The current is to operate an electric tricycle for cutting out the pace on the wheel track. It was exhibited at the cycle show held last month in San Francisco. It is operated by trolley connection, but the trolley is at the side instead of on the top. The conductor will circle the track. The machine will be in charge of a motorman, and can be run up to a speed of a mile a minute. The wheels of the machine are 30in. in diameter. In the patent claim it is set forth that the object of the invention is to provide a mechanism which is especially adapted as a pacemaker to be used in trials of speed for bicycles in connection with a wind break or shield, which will protect the rider from the resistance caused either by the wind blowing directly against him or the current formed by his own rapid speed. The vehicle is three-wheeled, and is provided with a seat from which the operator manipulates the controlling mechanism. From the front part of the frame of the machine trolley poles extend toward the sides, and carry a trolley wheel which engages the conducting wire. To the machine frame is secured the wind shield, which consists of plates of sheet steel meeting in front at an acute angle, and opening out toward the rear so as to encompass the vehicle, and at the same time to provide a space of sufficient width for the protection of the rider from the wind so long as he remains close to the machine. The apparatus is intended to run on any track, and it is retained in its working position by a framework, one side of which is fixed to the vehicle, while the other extends inwardly to a line parallel to the inner kerb of the track, and having journalled upon it vertical guide rollers. These rollers travel on a permanent guide, which is fixed parallel with the kerb in such a manner that when the guide rollers travel upon that guide the vehicle will be constantly retained at an even distance from the inner line or kerb. Should the practicability of the pacemaker be thoroughly demonstrated it will doubtless become an important factor in the lowering of existing bicycle records.

Royal Society's Soiree.—The first conversazione of the season was held on Wednesday at the Royal Society's Rooms, Burlington House, the guests being received by Lord Kelvin, the president. The attendance was large and the exhibits numerous. In a darkened room, Prof. Roberts-Austen showed an electric furnace for dealing with intractable metals, and in his crucible he melted titanium and chromium and boiled away silver in a vapour at a temperature of somewhere about 2,500deg. C. Prof. Ewing showed the magnetic tester for hysteresis which he brought before the Institution of Electrical Engineers the other evening. Dr. Hopkinson gave experiments on the effects of currents in iron on its magnetisation. Mr. Crompton also had exhibits—namely, apparatus for electric cooking and heating. Sir Benjamin Richardson brought a portable electric cabinet for use in hospitals, and Prof. Ayrton an instrument for determining the mechanical equivalent of heat. Specimens of the deposits which have been formed on the electric lighting mains in St. Pancras were exhibited by Major Cardew. Dr. Fleming had an apparatus for indicating the curves of alternating current, and Prof. Forbes was to the fore with a model illustrating the process of signalling by submarine cable. For an arrangement by Mr. L. Pyke, termed the "hydrogen wall," it is claimed that an increased efficiency in the reduction of the highly electro-positive metals is obtained. Among other metallic exhibits by Messrs. Johnson and Matthey, was a specimen of ruthenium melted by electric arc. In Major Holden's optical electric meters the readings of the dials can be magnified to any extent, as in the Thomson galvanometer, with the advantage that all the working parts of the instruments may be of the smallest dimensions, and be worked by the least consumption of energy. Lord Armstrong showed through the lantern the results of some recent experiments on the electric discharge in air, which were extremely curious and interesting. Prof. Ramsay did not omit to deal with argon, nor Prof. Vivian B. Lewes with acetylene. There were also astronomical and biological exhibits.

Secular Variation of the Earth's Magnetism.—In a recent publication by Dr. L. A. Bauer, entitled "Beitraege zur Kenntniss des Wesens der Saecular Variation des Erdmagnetismus" (Inaug. Diss., University of Berlin), some interesting and important contributions to our knowledge of that enigmatical phenomenon of terrestrial magnetism—the secular variation—have been made. The author has constructed the actual curve described in the course of centuries by the north end of a "free magnetic needle" at various stations (24) distributed over the globe. The result has been the establishment of a law governing the direction of the curve, which the author claims is the first law that has been established thus far with regard to the secular variation as applying to the whole earth. This law may be expressed as follows: the north end of a freely suspended magnetic needle, as viewed from the point of suspension of the needle, moves, in consequence of the secular variation of terrestrial magnetism on the entire earth, in the direction of the hands of a watch. With regard to the period, Dr. Bauer believes that it has not yet been proved that the earth actually possesses a common secular variation period. The only way he thinks it possible to deduce a common period is by the supposition that the curve described by the magnetic needle is not a single closed one, but consists of loops. Indications of such loops, he says, make themselves apparent at various stations. A comparison is also drawn between the secular variation and the momentary distribution of terrestrial magnetism. A secular wave is followed around the earth with the aid of the projected curves. It would appear as though a continuation of the secular curve is obtained by going around the earth eastwardly. The fact thus revealed, the author says, would have, as a direct consequence, that if a survey be made along a parallel of latitude in an easterly direction, a similar motion of the magnetic needle would be encountered as in the case of the secular variation. Dr. Bauer has carried out this idea for three epochs—viz., 1780, 1829, and 1885—and along several parallels of latitude. The curves described by the needle are projected and given on a special plate. It has been found that in every case the north end of the needle, as observed from the centre of the needle, moves clockwise. Furthermore, by a comparison of both sets of curves—the secular and the momentary—it would appear as though they are subject to similar laws.

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LEICESTER ELECTRICITY WORKS.

(Continued from page 475.)

The opening ceremony of the Leicester Corporation electric lighting works was described in our last issue, where a general description of the system of the supply and of the commercial aspects of the work will be found. The report of the speeches on the last two toasts were unavoidably crowded out.

Leicester Municipal Buildings.

Sir COURTENAY BOYLE, responding to the toast of "Trade and Commerce," remarked that he was immensely touched with the extreme warmth of the reception, and that he should go away from Leicester carrying with him a feeling of gratitude which would last to his dying day. He was especially glad to be present on that occasion, because it devolved upon him in 1889 to advise the Board of Trade with regard to the granting of the provisional order under which the Electric Lighting Committee of Leicester were now acting, and it seemed to him to be very apposite that having taken part in the commencement of the work he should come and see its satisfactory and healthy completion. In some points they were to be especially congratulated in Leicester in the matter of electric lighting. There were no overhead wires in Leicester, and they were spared not only the unsightliness, but the physical and mechanical danger which overhead wires had been proved to create. In the second place, both their gas and their electricity were managed by the same body and the same engineer. It was eminently satisfactory to know that should it be discovered that in one of the transforming-chambers of the town there was a leakage of gas which led possibly to an explosion, it was competent for their engineer, without consulting another department, to go at once and put that right, and prevent a recurrence of that leakage in the future. They had heard a great deal from time to time about the municipalisation of these

ALDERMAN LENNARD,
Chairman of the Leicester Electric Lighting Committee.

ALFRED COLSON, M.I.C.E.,
Borough Gas Engineer, President of the Incorporated Institution of Gas Engineers, Examiner in Gas Manufacture at City and Guilds of London Institute, Designer of the Leicester Electric Light Station.

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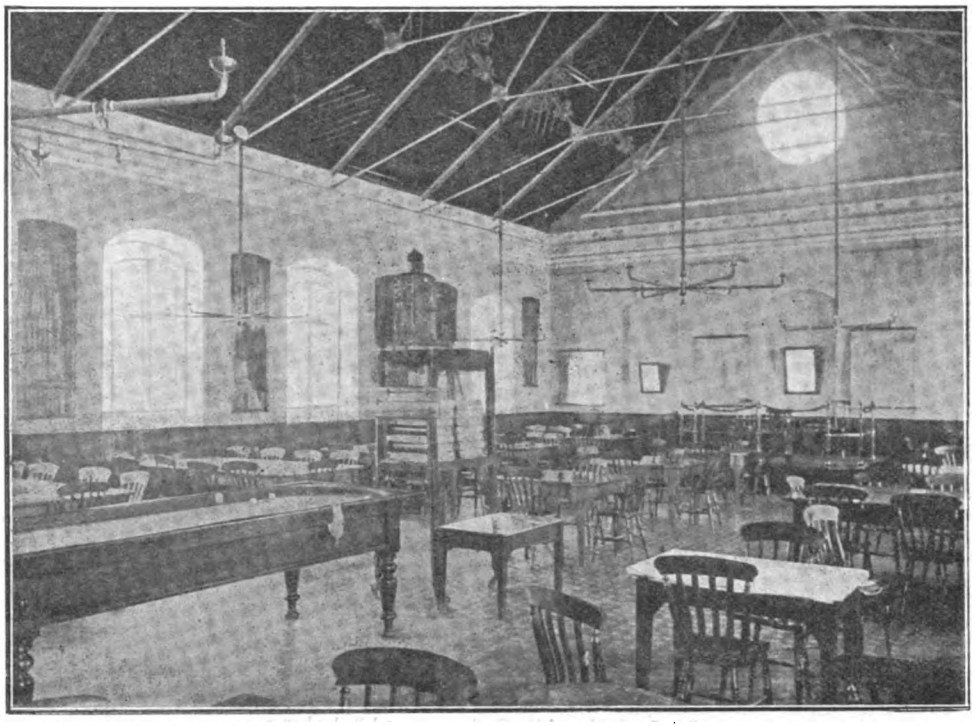
undertakings. All he could say was this, that up to the present such results as those had been achieved by municipal bodies like their own without any impairment of that individual energy upon which their trade and commerce so much depended. He would say that, whatever might be the future of electricity—and he for one most earnestly believed it had an enormous and perfectly unknown future before it—the invention of their scientists, the capacity of those who were already engaged in inventing new outlets for their electrical energy, would not be of much avail unless they were made use of by such municipal energy and enterprise as their committee had shown in this matter.



Library at the Leicester Electric Light and Gas Works in which the luncheon was held.

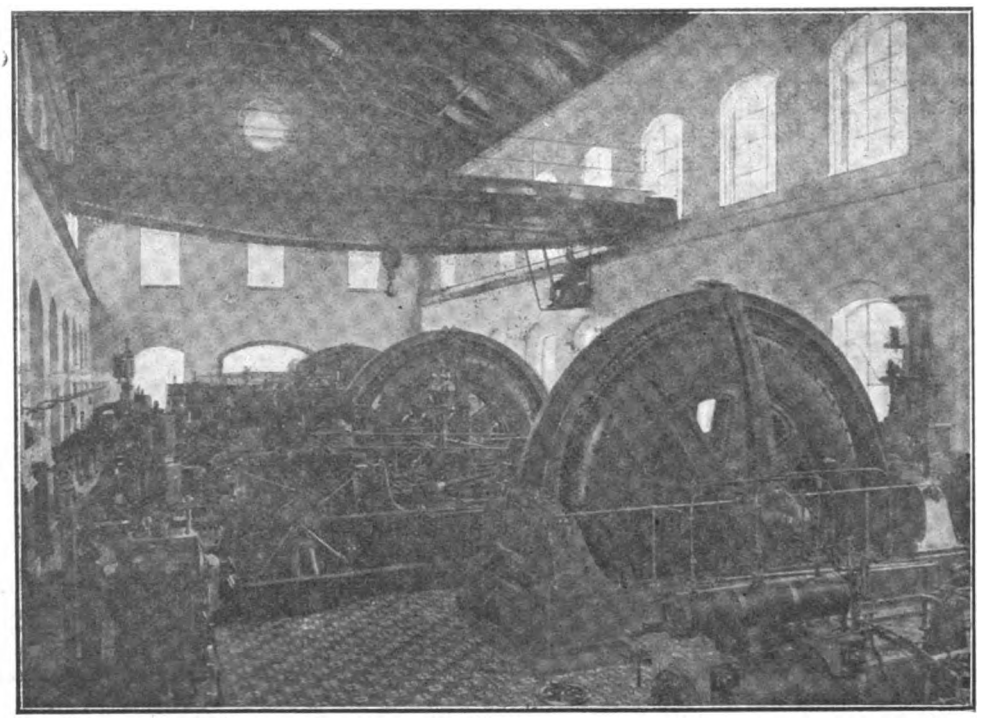


FIG. 6.—View of the Generating Machinery from East Corner of the Engine-room.

In replying to the toast of "The Engineer," Mr. A. COLSON said that it was always encouraging, after carrying out arduous duties, to know that one's efforts met with approval and success. It was more than gratifying to him to hear that the Leicester electric lighting station was, in the opinion of those whose judgment could be relied on, equal to any in this country. Whatever he (Mr. Colson) had done towards bringing about such a result had been done with pleasure, and carried out with an eye to the future requirements. He alluded to the gentlemen who had so ably assisted him in the work, especially mentioning the joint labours of Messrs. Raworth and Mordey. Mr. R. W. Hudson had by his high mechanical attainments fully sustained the high reputation of the firm who made the engines. He also expressed the gratification he felt to the Corporation and the Electric Lighting Committee for the confidence they had placed in him and for the appreciation they showed of the results obtained.

Mr. HUDSON then replied to the toast of "The Contractors," and the company separated after giving a vote of thanks to the chairman.

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General Arrangement of Plant.

The ground plan of the electric lighting station was shown in Fig. 3, p. 473, from which the relative positions of the various parts of the generating plant will be readily seen. The 75-kilowatt alternator and engine is placed near the entrance; the other three alternators are each capable of giving 200 kilowatts. Fig. 6 shows a perspective view of the station taken from the corner next to the engineering workshop. From it a good idea of the appearance of the machinery and the general finish of the work is obtained. Fig. 7 is a working drawing of the section of station, and should be looked at by the side of Fig. 3. From these two full particulars can be gathered, and it will be seen that the floor level of the engine works is practically that of the boiler-house. The whole of the steam and exhaust pipes, and the condensing connections, are placed underground in the extensive cellars round the foundations. The ground plan gives some idea of the extent of the accommodation thus provided under the engine-room floor, and in which are conveniently arranged all the wires from the exciters to the alternators, and also the mains from the alternators to the switch pillars. The pipes range along one side of these cellars, and can be approached at nearly all points from wide passages between the foundation. Thus the difficulty and danger, so often found when underground steam-pipes are used, of having to reach a

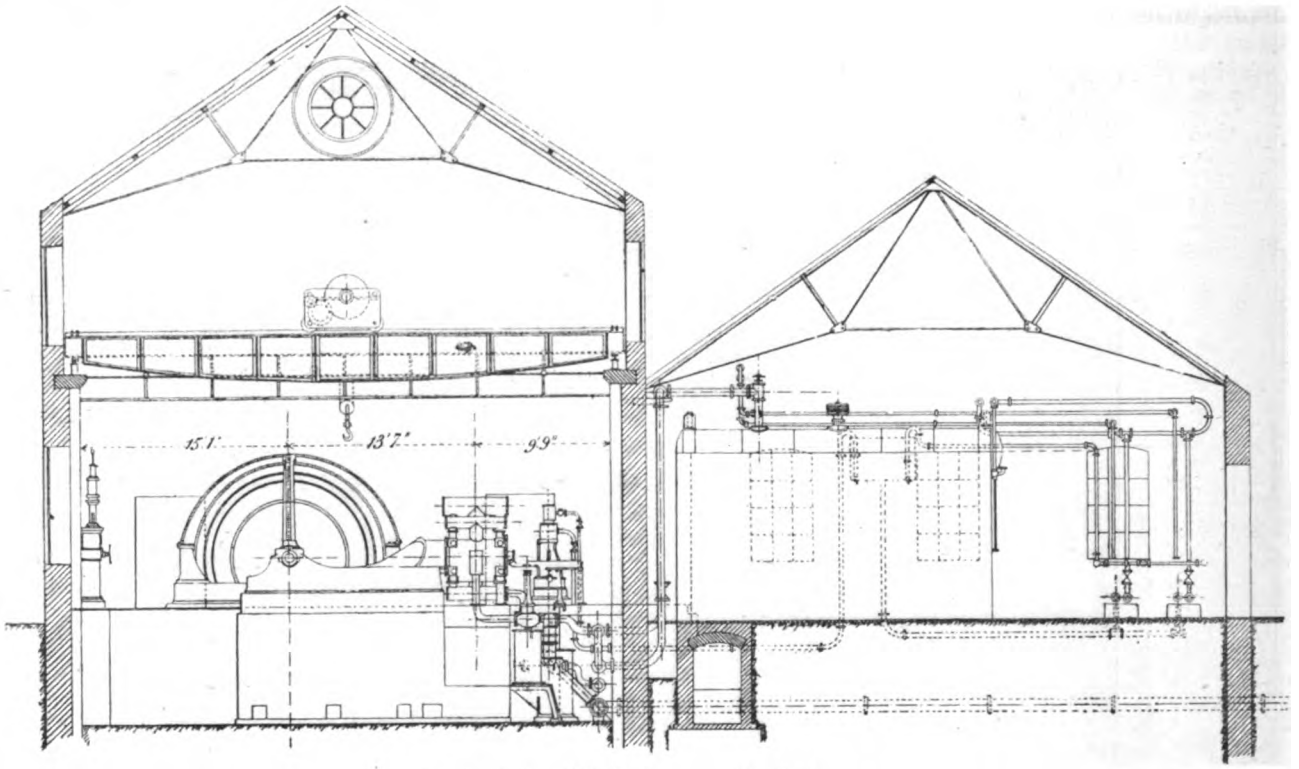

FIG 7.—Section of the Engine-room and Boiler-house.

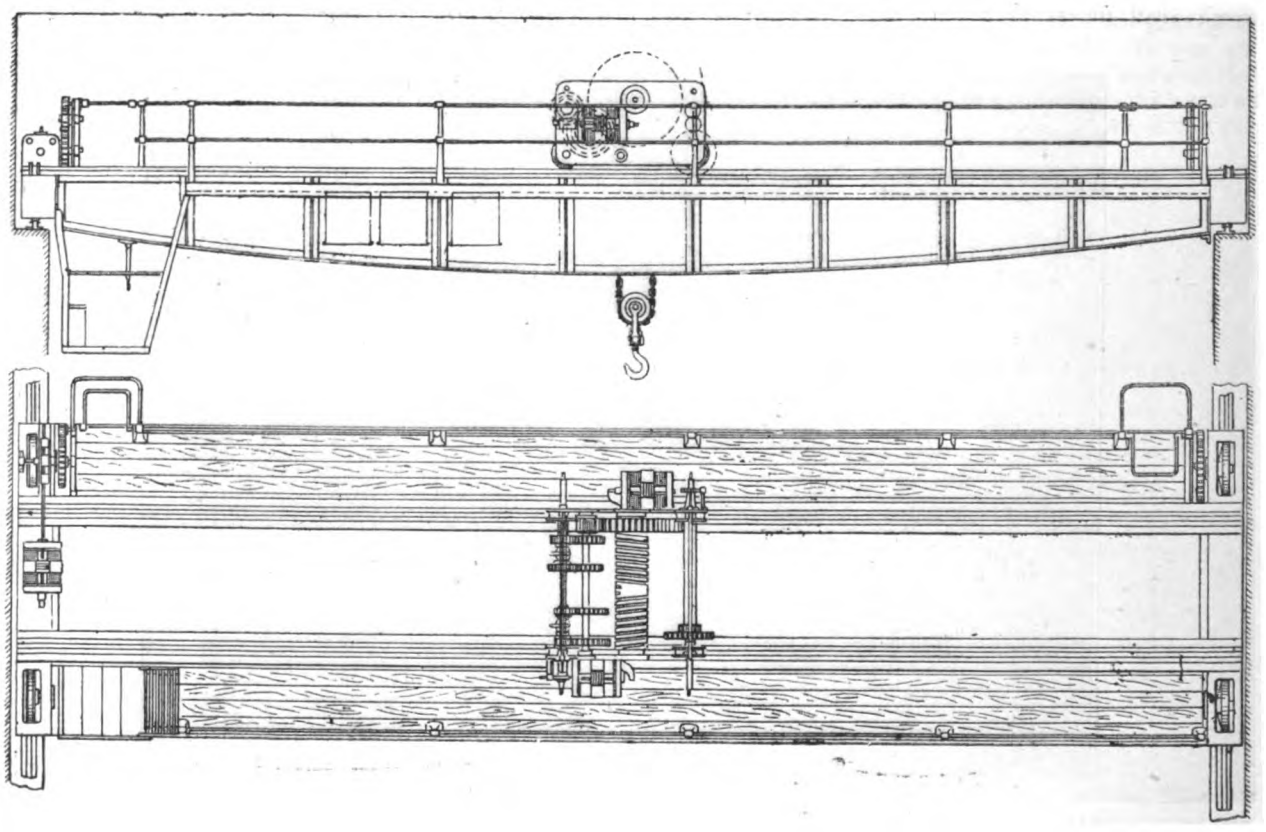

FIG. 8.—Electric Traveller worked by three Brush Motors.

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leaky joint by walking along the narrow channel containing the pipes, is avoided. Under the floor on the northern side of the building, the cellar spaces are fitted up as oil and general stores. All the foundation bolts run down to the cellar floor line, and are accessible should any need for withdrawing them arise.

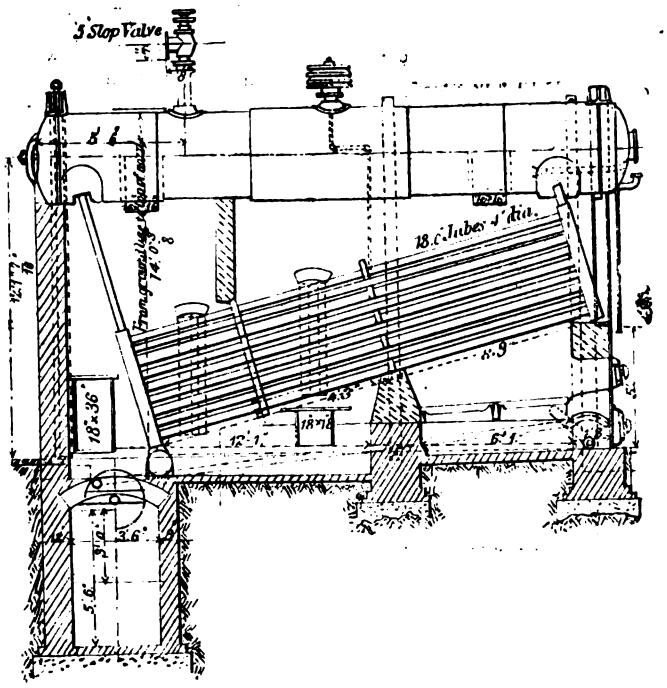

FIG. 9.—Section of the 124-h.p. Babcock-Wilcox Boiler.

A 15-ton electric travelling crane, Fig. 8, runs the full length of the building. Three Brush 4-h.p. series motors are employed to work this crane, one being used for each motion. In this way all transmitting shafts or ropes are replaced by electrical connections. The whole of these motors are controlled, both as to direction of rotation and speed, from a cage below the traveller. From his position the operator commands full view of the whole of the engine-room, and can judge the required movement of the crane with accuracy. The motors transmit their motion to the working parts of the crane by worm gear specially designed by the Brush Company. The worm shaft has roller thrust bearings to reduce friction. The worm is of the best cast steel and gears into a gunmetal worm wheel, the whole gear running in oil. The motor giving the longitudinal motion to the traveller is connected direct to its resistance and switch gear, but the other two—one for lifting and one for the traversing gear—have movable contacts. The current is conveyed to each of these last two motors by collecting brushes, bearing on copper strips running the length of the traveller. Four such strips are used for each motor to enable it to be reversed from the cage. These four copper strips can be seen in Fig. 8, on the inner sides of the two main girders. The motors are direct-current, and are supplied at 50 volts from the exciter sets. The regulating resistances are supported on frames on the underside of the travellers; the regulating switches are so interlocked with the reversing switches that the connections can only be reversed when the regulating switch is in the off position. The omnibus bar supplying the motors is supported on insulators along the length of the engine-house, and a brush fixed on the traveller collects the current as the traveller moves. The return is effected through the wheels to the traveller rails.

Steam-Generating Plant.

The boiler-house is placed behind the engine-room, and arranged to take one more set of boilers when the demand for steam increases. The station is designed with a view to extensions, and the next boiler-house would come on the other side of the chimney, the engine-room being also extended in the same direction. Four boilers of the Babcock-Wilcox water-tube type are at present fixed in the boiler-house in two sets, as is the usual practice of that firm. Each boiler is of 124 actual horse-power, and is composed of seven sections each containing nine 4in. tubes 18ft. long, and has a heating surface of 1,426 square feet, with a grate area of 26½ square feet. The steam-drums are 3ft. 6in. and 23ft. 6in. long, and were tested to a pressure of 225lb. per square inch, the working pressure being 120lb. The boilers have all the usual mountings, the safety-valves being of the Turnbull dead-weight type, and the water-gauges of Dewrance's make. Coke is used in these boilers, owing to the cheapness of this fuel in the gasworks. Fig. 9 shows a section of this boiler and the dimensions of the underground flues as used at Leicester.

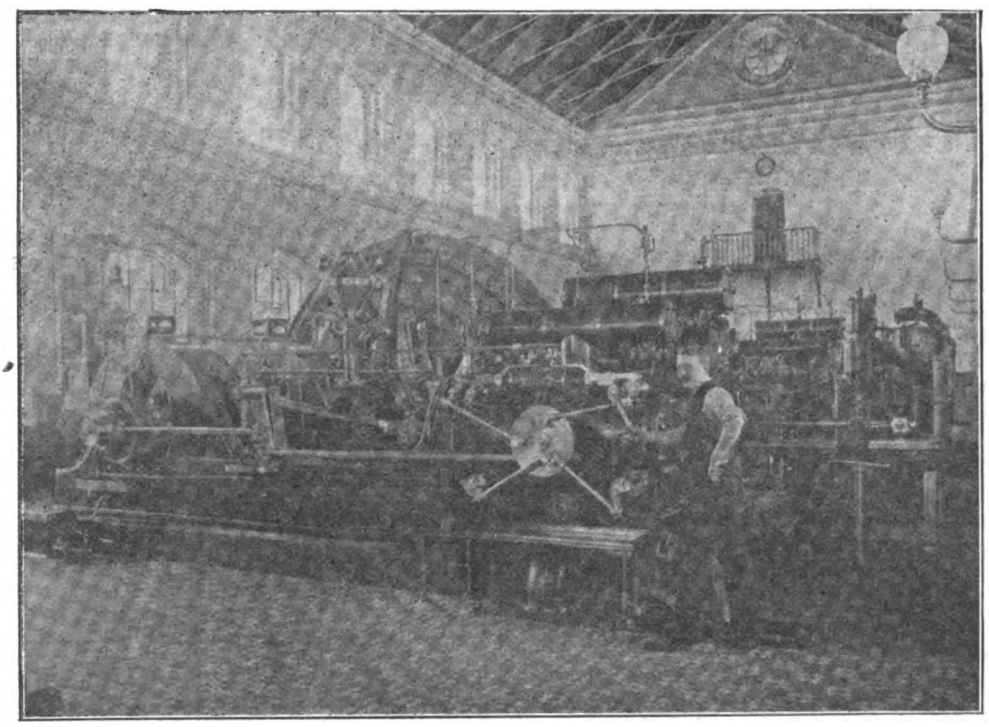

FIG. 10.—200 K.W. Steam Alternator

Feed Arrangements.

The feed water for the boilers is supplied from a large wrought-iron tank, holding 600 gallons, into which the exhaust steam from the exciter and feed-pump engines is delivered, thus heating the water before it passes through the economisers to the boiler. The economiser is of the

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Babcock-Wilcox type, and has 2,600 square feet heating surface. It is composed of 16 sections, each of 12 3in. tubes 16ft long. The position and arrangement of this apparatus is shown in general plan, Fig. 3.

Two three-throw vertical feed-pumps are installed. These were manufactured by the Brush Company, and are each coupled direct, on one bed-plate, to a Brush 4in. by 4in. vertical steam-engine. Each pump is capable of supplying the necessary feed water when the whole of the generating plant is running, and the connections are such that a direct cold feed can be supplied if needed. The feed-water pipes are of galvanised iron, 3in. in diameter, arranged in duplicate, with valves at suitable intervals, to allow of repairs without interrupting the supply, as will be seen on the plan.

Steam and Exhaust Pipes.

The main steam-pipe is of wrought iron, 6in. in diameter, and arranged as shown in the general plan and elevation (Fig. 3). Valves of the straight-through parallel type are used at frequent intervals, so that any section may be isolated for repairs. The exhaust-pipe is of cast iron, as are also the injection-water and air-pump discharge pipes, and range from 12in. in diameter downwards. The condensing water is obtained from the canal running through the gasworks. The steam-pipes are lagged with magnesia sectional covering, and Geipel's patent steam-traps are used to drain off the condensed water.

The Engines.

The engines used to drive the flywheel-alternators were made by Messrs. Hick, Hargreaves, and Co., of Bolton, and are of the horizontal type with Corliss valve gear. There are, in all, four pairs of compound engines—three of 300 b.h.p. and one smaller pair of 112 b.h.p. The larger engines, Fig. 10, have cylinders 16in. and 30in. in diameter and 3ft. stroke. These are coupled by means of a Raworth coupling direct to Brush alternators, which they drive at a speed of 96 revolutions per minute. Both cylinders are fitted with Corliss valve gearing, and are thoroughly steam-jacketed. The cylinders are built up of separate castings, which consist of four pieces—namely, a liner, a casing, and two end valve-chambers. The advantages of this system of construction are obvious, as it means the substitution of four simple castings, which can each be cast of a mixture most suited to its special purpose. A single casting is of so complicated a nature that it can only be cast of a comparatively soft mixture, and it is even then liable to fail from initial stress aided by unequal expansion.

The system of steam-jackets used in these engines deserves special notice. The steam passes completely round the jackets on its way to the cylinders. This method of jacketing is almost universal on the Continent, and is largely used in America, the lowest steam consumption ever recorded having been obtained from engines jacketed on this system. Messrs. Hick-Hargreaves adopted this system some time back after careful consideration, and are well satisfied with the results since obtained. Its advantages are obvious. There is no possibility of any accumulation of air or water in the jackets, the volume of steam passing through them being so great as to sweep away and prevent the formation of any accumulation of air or water. It also renders it impossible to heat the jackets without heating the cylinders, and the great strains due to unequal expansion and contraction are thus avoided. The efficiency of the jackets as a heating medium is also greatly increased owing to the comparatively high speed with which the steam passes over the surface to be heated. There is a steam-jacketed receiver between the high and low pressure cylinders, in the jacket of which the full boiler pressure is always present. The low-pressure cylinder has the same system of jackets, and the steam from this receiver passes completely round the cylinder before reaching the admission ports.

The main frame of the engine is of the box form, and is made very deep in order to form efficient crank race oil-drippers. The cylinders are attached to the end of the bed-plates by means of hood-pieces, sometimes called target ends. The valve gear differs from that of the usual type, having been designed especially to meet the demands for dealing with the great and rapid variations of load peculiar to electric lighting, with a minimum variation of speed. The gear, which can be seen in Fig. 10, gives very good and rapid port openings and a great range of cut-off—*i.e.*, from nothing up to three-quarter stroke. The governor controls the cut-off in both high and low pressure cylinders, a system believed by the makers to be essential when dealing with great variations in load. The piston rods, cross-heads, crankshafts, and valve-gearing are of steel. The governor is of the high-speed pattern modified Proëll type, with a heavy centre weight on the spindle. Means are provided for altering the speed of the engines slightly for synchronising purposes, and there is a safety stop motion fitted to the governor, which stops the engine at once in case the belts driving the governor break and the latter falls to the bottom, or if from any cause the engines should get so much overspeed that the governor rises to the top of its range. The crankshaft is of the double-throw type, made in two pieces, bolted together with solid flanged couplings forged on the shaft, the flanges of the coupling forming the seat on which the belt pulley driving the governor is fixed.

The air-pump and condenser stand behind the low-pressure cylinder, the latter being of the jet type. The air-pump itself is of the vertical single-acting description, and is driven by means of wrought-iron lever links from the tail end of the low-pressure cylinder piston rod, which is prolonged for this purpose.

The smaller 112-b.h.p. engine is of general construction, similar to that described above, except that on the low-pressure side a slide-valve is used instead of the Corliss gear. The cylinders of this engine are 11in. and 20in. in diameter respectively, and 2ft. stroke. Running at 118 revolutions per minute, they develop some 112 b.h.h.p.

The finish of the whole of the parts has been most carefully attended to by Mr. Colson's special request, and the general appearance of the engines is most pleasing. Well-polished brass oil-catchers are placed under the Corliss gear, and the steam-pipe connections have metallic coverings over the lagging.

The work of erecting these engines at Leicester was carried out by Mr. W. E. Barton, who has since joined the staff of the Corporation.

(To be continued.)

ALTERNATING AND INTERRUPTED ELECTRIC CURRENTS.*

BY PROF. GEORGE FORBES, M.A., F.R.S., M.I.C.E.

(Continued from page 477.)

I will not delay you with these any longer; a series of beautiful experiments may be done with them. I will show you another example, where the ordinary intelligent man with a mechanical knowledge does not immediately realise what is going to happen when a certain experiment is going to be performed. I have a disc of ordinary cartridge paper loaded at the circumference by means of weights, and I shall give a considerable speed of rotation to the disc; and I shall bend this disc while it is in rotation, and I do not think that the result will be exactly as everyone would have expected, Fig. 3. Now we leave it alone, and I do not think that everybody here would have expected it would retain the same shape continuously for so long a time. I go faster, and you see that there is a force which is tending to lead it back to the vertical. In time it would come back to the vertical position.

These are all phenomena dependent upon momentum, and a great number of those in the electrical experiments which I wish to show you are equally dependent upon what is called electrical momentum. Electrical momentum usually goes by the name of "self-induction," and I shall have frequent occasion to use it; and as you have seen the effect in these cases, you will remember momentum is the analogue of self-induction. These experiments also involved a certain pliability (*e.g.*, of the chains), flexibility, ability to move, and a natural tendency to return if not affected by other causes.

Many of the electrical experiments I shall have to show you depend for their action upon electrical flexibility or yielding, which usually goes by the name of electrical capacity. These two things, capacity and self-induction, are the two most interest-

* Lecture delivered before the Royal Institution.

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ing things which come into the course of these lectures. I shall have to deal with them pretty largely.

Now, I had hoped to have begun this course of lectures with a very striking experiment which I thought was particularly appropriate because it was due to Faraday, and was performed here by him long ago. He discharged a large number of Leyden jars, and tried to discharge them through a lengthy wire; but the discharge preferred to cross from one end of the wire to the other end instead of going round the circuit, although

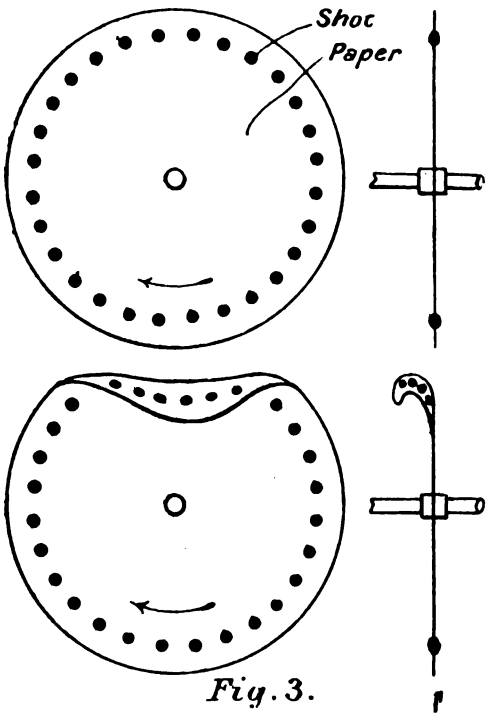

Fig. 3.

that metallic conducting circuit was there, and you would have thought it would go round it. Having, unfortunately, relied upon one who I thought was certain not to fail me, but who has failed me, I have had to abandon the experiment. I would have liked to show it because in that experiment is involved nearly the whole of the principles of the various things I wish to bring before you in the course of these lectures. Instead of bringing all things grouped together in one experiment, and then separating them out, we shall have to proceed to take them separately.

Now, I wish to show you before we go on what is the mechanical analogue which I wish in these lectures to follow up in the study of electric current. The water analogy which I have spoken of is very useful, but I am anxious to draw your attention to the other mode of expressing it, and I will just do so by means of a model here. I have an electric circuit here, and this is an analogy of it.

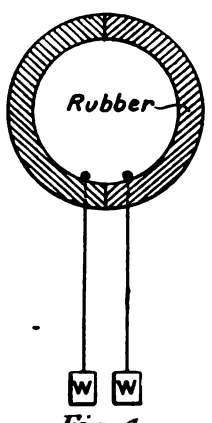

Fig. 4.

There is a central station at the top and there is a power-house at the bottom where the power is going to be used. These are represented on the vertical ring I hold. I have to apply an E.M.F. The energy is purely a mechanical force—a twisting force. I then give a certain twist. By applying the force up here I apply a certain twist to the indiarubber tube, and this force lifts the weight at the bottom, Fig. 4. That is a very simple thing, and therefore it is all the better for illustrating what I wish to say. We may have a continuous current, in which I always wind it up in the same direction, or we may have an alternating current, in which I twist it in opposite directions. The resistance in this case is entirely due to the distortion of this indiarubber, but any other form of friction would do just as well. For example, if I take one of these strips of telegraphic paper and twist it round at the top, there is a certain amount of air friction resisting the twisting; or I might suspend in water or oil anything I wish to twist, and that would illustrate it in the same way.

Now, the first thing I wish to give a little idea about capacity. Of course, as I mentioned, an Atlantic cable has certain amount of capacity, a considerable capacity, and it shows itself by a charge upon the outside of the cable. To illustrate this more clearly, I will just go through the experiment of charging a Leyden jar and then discharging it, just to show you what I mean by capacity and what I mean by something which will hold a charge. [*Experiment.*] Now, an Atlantic cable consists of a wire surrounded by insulating material. The wire is the one conductor—we will call it the internal coat—and the sea is the outer one, and this is to be charged to a certain potential or pressure which you are using. Now, to charge any portion of it, that involves the passage of a certain quantity of electricity through the cable. But the current cannot pass instantaneously through the whole length of the wire because the condenser action is demanding a certain supply for every section of cable as you go from one side of the Atlantic to the other, and the resistance of the wire will not allow it to flow more rapidly than at a certain rate with the number of batteries you happen to be using. That is the foundation of the difficulty that arises in dealing with submarine cables.

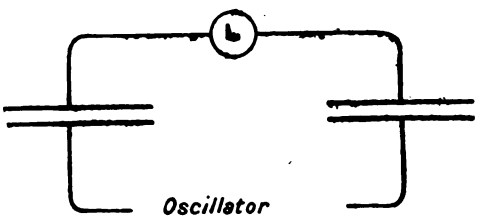

Fig. 5.

Now, I wish to illustrate this question of capacity to make it a little more clear, and will do so at the risk, perhaps, of confusing you a little; but I will try to avoid that. I have here an arrangement by means of which I can charge and discharge a condenser with extreme rapidity. The amount of electricity which a Leyden jar can hold is extremely small. Faraday used to say that in decomposing a drop of rain there is far more electricity used than there is in a lightning flash. The little Leyden jar which I used just now is capable of holding but a very small quantity of electricity, and the condenser which I am going to make use of immediately is capable of holding still less, and holds very little electricity indeed. But by using a current interrupted with extreme rapidity, and reversing it, I am able to supply the current at very rapid intervals, so that the total quantity which passes in one discharge is very small, but the total quantity which passes in the course of a second is very large indeed owing to the enormous number of discharges which take place in the course of a second. I am going to show you

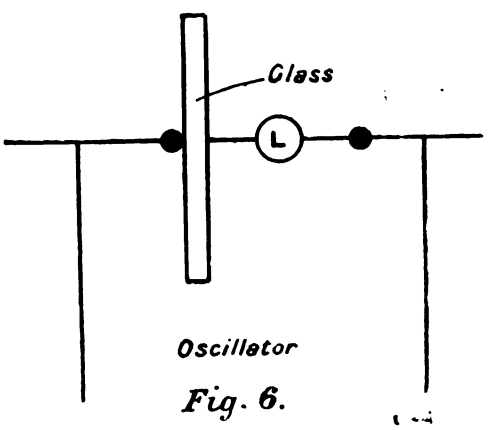

Fig. 6.

that by using two pairs of tin plates we have two condensers of far less capacity than that of the Leyden jar which you saw just now, and yet their capacity will be sufficient with the enormously high pressure I am going to use and the very rapid alternations to provide a current sufficient to light an incandescent lamp, which is really a considerable quantity indeed. I now take the two top plates of the condenser and place them over the others, and you see a light glowing. I can place them still lower, and you get a brilliant illumination passing through that extremely simple capacity, simply owing to the hundreds and thousands of volts we are using and the enormous frequency of alternations, Fig. 5.

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Now, while I have this apparatus I will show you the effect in a more exaggerated manner. I am going to use simply two points separated by a glass plate. The capacity of this arrangement is something almost infinitesimal, and yet by using these enormous electric pressures and the high frequency which we are employing, we are able to get light enough to light a lamp. I lean a glass plate against one of the terminals, and to the other terminal I attach an incandescent lamp with a wire leading up to the glass plate. Now, the capacity of that jar is really almost infinitesimal, and yet there is a sensible amount of electricity passing into and out of it during the time I am exhibiting it, Fig. 6. This is a very striking experiment, and as I have got this here I will show you what the capacity of my own body is. I think you may take it that this ground is completely insulated, and that there is no current capable of going through me to the ground. Therefore, since the lamp is only attached to one of the terminals, the current has no complete circuit to pass round, and when I touch this it is only by charging my body and then discharging my body that the lamp is able to lighten up, Fig. 7. There is the lamp lighted and sending a current through my body, and utterly imperceptible to myself.

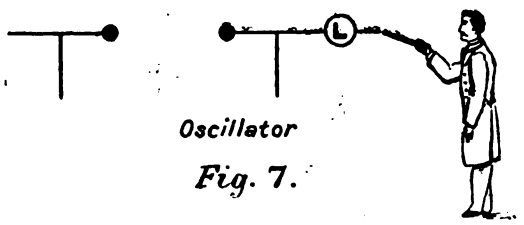

Fig. 7.

Now, capacity is what I am going to deal with chiefly to-day, and most of the rest of my lecture will be devoted to illustrating the Atlantic cable. But I will first show you the kinds of models that I have found instructive, and they are of the rudest and most elementary characters; and as soon as you realise what you can do by thinking over these simple models, and the perfect analogies you can get to the electrical phenomena, I am sure it will be a very great help to you in working out any electrical problems or in thinking what is going on in any electrical problem.

Well, in the first place, I am dealing altogether with twisting of wires. I consider that the E.M.F. is the force with which I twist it. I can measure the force with which I twist anything by winding a wire round it and letting it go over a pulley and putting a weight on it, Figs. 8, 9, 10, and 11. That force is the E.M.F. Here I have a central station with a twisting force, here I have the line going to a distant place, and there I have a resistance, and a resistance eventually such as to equalise the force I am exerting. There is also a definite velocity of rotation attending, which is analogous to the current. Therefore in these models twisting force is the E.M.F., friction is resistance, and velocity of rotation is electric current. In such a station I can have either a continuous current, ever going round in the same direction, or I can have an alternating current, going first in one direction and then in another. In each case, if the wire is perfectly stiff, it is pretty easy to follow the phenomena which are going on.

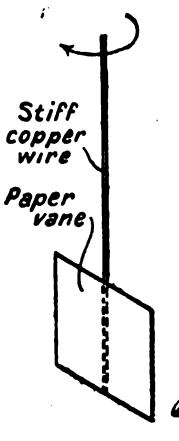

Fig. 8.

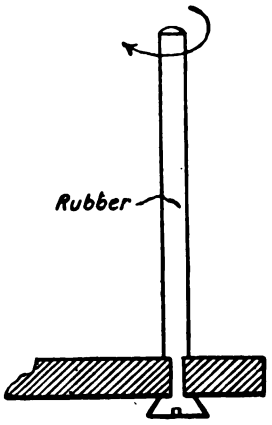

Fig. 9.

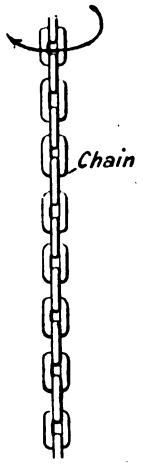

Fig. 10.

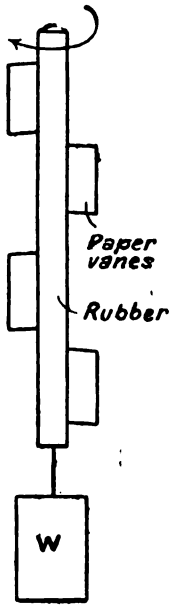

Fig. 11.

Now, I have a number of other cases. You may take any mechanical devices for these illustrations, and you can find electrical analogues. Here is a case. Suppose I twist that elastic string at the top and keep it fixed at the bottom—what is that equivalent to? It is equivalent to a cable of large capacity which is insulated from the earth, and not free. In that case there is a certain charge given to it with any E.M.F.; in other words, there is a certain twisting given to it, with an ounce weight, for example. Therefore we are able to conceive of capacity as a yielding in the same direction, and the charge is the amount of that yielding. A twisting, flexible thing like this is a charged cable. I have here something which represents a combination of flexibility in the cable, which is the capacity of momentum at the far end, which is self-induction, and of air friction, which is resistance; and if I pass alternating currents through that, you will notice that the progress is in a sort of wavy motion down the length of the line. Exactly the same thing happens in the electrical case, provided you have your units in the two cases proportionate to each other. Here I have a heavy chain. When I twist this chain round backwards and forwards it does not all rotate at the same time; that is due partly to its having pliability, which is capacity, and also weight, which is momentum. The weight prevents the motion being communicated to the whole length at the same time.

And now I wish to draw your attention to submarine cables. Before going on to the analogies in that, I will simply show you how a trough of water is an analogy of a submarine cable. This trough has capacity at every part of it, because the level can rise; thus in every way the propagation of a wave along the trough is analogous to the propagation of a wave in a submarine cable—in fact, it is a very accurate analogy indeed. To illustrate it, I will simply make a few waves, and you will see the propagation of the waves along the whole length of the level surface, the change of level taking some time to reach the far end, Fig. 12. That is what happens in the case of a submarine cable—it takes some time to reach the far end.

I wish now to show you a most curious thing. I have here a string suspended from a spring with a set of vanes and two nozzles for blowing against the vanes; there is also a thread coming down through the glycerine and water in the tube, and at the bottom I have a mirror, from which I can reflect a beam of light. The mirror might be attached to the bottom by a spring, but instead of having a spring I have an obvious method of attaching a small magnet to the bottom, and using controlling magnets. Let me refer you to this diagram. The spring acts as a condenser, and the air-blast and the vanes take the place of the battery. The spring below takes the place of the condenser. That is an ordinary way of sending messages through an Atlantic cable. But before doing this I wish to show you the phenomenon of the retardation of the current in an Atlantic cable—that is to say, by means of those artificial cables which are made by Dr. Muirhead, who has assisted me so much. Dr. Muirhead's artificial cables are made of tinfoil, cut in that shape so as to have high resistance. Opposite to it is placed another perfectly flat, which is connected with the earth, which acts as the sea. They are separated by paraffin. He builds up his cable that way, and thus makes an Atlantic cable. Now, to show the retardation of phase. This galvanometer is connected with the sending end; the current will then pass through the whole length of the cable and come out at the other end, and, passing through the galvanometer, there deflect it. The movements of these galvanometers will be seen by spots of light shining on the screen. Now, Mr. Edgar is going to send a signal through the cable, and what you will have to observe is that the sending galvanometer is deflected immediately, and the other takes a long time before it is affected. [*Experiment.*] You can see the interval

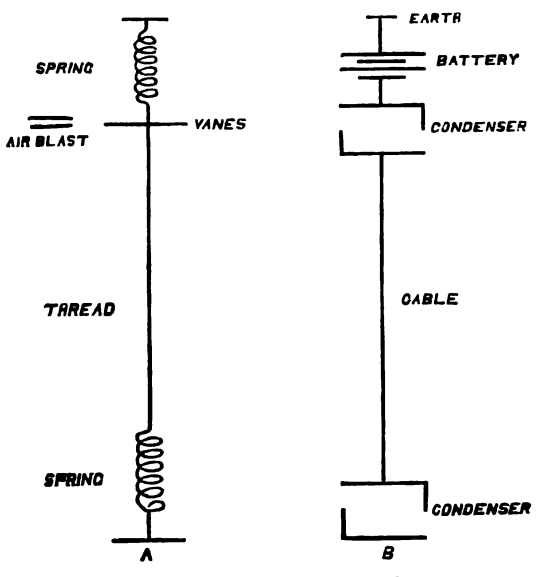

FIG. 12.—A B represent Earth.

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of time between the sending signal and the arriving signal, and you also see how gradually the arriving signal creeps up. Exactly the same is noticed when I rotate the vanes at the top of the thread hanging in the tube of glycerine that I have just described to you, and the deflection of the mirror at the bottom is noted. This, I have to say, is really, if you choose your units, a perfect representation of the Atlantic cable. I would like to devote a little more time to show how by measuring the twist you can get the capacity and the resistance. Time will not permit me to do that, but I may perhaps have more to say about that on another occasion.

I will now show you some further illustrations of this. I will begin with using the suspended thread in order that we may see and calculate beforehand what we ought to expect from the cable. We will use the suspended thread first without a curb. Let me tell you what a curb is. In the Atlantic cable it is found that if you simply send a positive current through, the signal arrives in a certain manner which would be perfectly satisfactory, but it is much improved if, after having given a positive current, you give it a short time afterwards a negative current. I will put it in another way. If you take a whip with a long lash, and you want to make a crack you may give a forward motion to the lash, and you get a certain amount of cracking; but you get a much sharper crack if you follow it with a backward motion. So here, curbing with my cable means giving it first a twist in one direction and then a twist in the other. Not curbing simply means giving a twist in one direction only. We will signal the letter S—that means three dots—to show you what does take place in a real cable. You will follow it by means of the spot of light you see on the screen. I want to show you the difference between curbing and not curbing. When you are telegraphing quickly, the signals bank up on the top of each other, and cause the spot of light to travel further and further away as the second and third dots come. With curbing this does not occur. Now, by depressing first the positive key and then the negative we can produce the equivalent of curbing, and Mr. Edgar will be able to show you that by means of the reflection on the screen. [*Experiment.*]

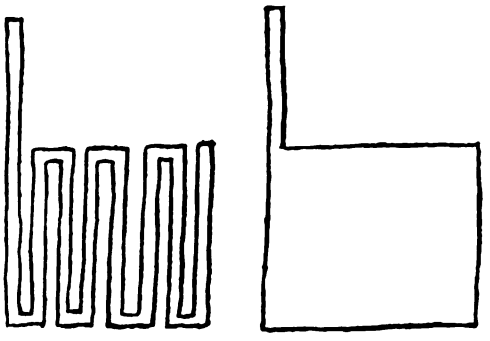

FIG. 13.

In conclusion, I wish to draw your attention to the beautiful apparatus which is used in the operation of transmitting through an Atlantic cable. In the first place, the message is punched out on a piece of paper, and it is punched so as to send the current in either a positive or negative direction. The strip of paper is afterwards passed through the transmitter, and as it is passed through contact is made through the holes, and the message is sent. We will now transmit a message through here. [*Experiment.*] As a matter of fact, the messages which are sent through the cable are received on an instrument called a syphon-recorder, which was originally invented by Lord Kelvin. There is in the curb sender I have on the table a most beautiful device, for while it is working I can, by turning this screw, vary the amount of current that is sent through the cable, and by varying it you are able to adjust the signals so as to get the most beautiful trace of the recorder possible; and also by this means, not using a condenser, but by direct signalling, you are able to get an increase of speed in some cables of about 25 per cent., which is a matter of great importance. I do not think there is time to go into much more, but I am able to show you a few specimens on cards of some signals made in three different ways: first, with a condenser; second, without a condenser; and third, without a condenser and with a curb, and the third is the best. I wanted a word with a good many "h's" in it, and so I selected the name of a member of this institution who has had a great deal to do with telegraphs, and there are the marks exactly as they came out drawn by the recorder itself—Hughes.

Electric Lighting in Spain.—A central station is to be erected shortly at Carthagena, a special feature of which is the fact that two Laval steam turbines, each of 100 h.p., are to be employed.

CITY AND GUILDS OF LONDON INSTITUTE.

ANSWERS TO THE QUESTIONS IN ELECTRIC LIGHTING AND POWER TRANSMISSION.

ORDINARY EXAMINATION, 1894.

(Continued from page 476.)

1. Describe and sketch some form of ampere-meter of a type which does not depend on the magnetisation of iron.

Instruments used for measuring current strength, and which do not depend on the magnetisation of iron, depend on the measurement of the mechanical forces between adjacent coils having current passing through them. Siemens's electro-dynamometer is an example of this class of instrument, and it consists of two coils, one of which is fixed permanently, whilst the other, composed of one or two turns, is suspended by a thread and controlled by a spiral spring. The current passes through the two coils in series, connection being made by means of mercury-cups, so that the movable coil is perfectly free. In the normal position the movable coil is in a plane at right angles to the plane of the fixed one, and when the current circulates through them the movable coil tends to place itself parallel to the fixed one, but this is prevented by turning the torsion index until the torsion of the spring balances the torque.

The mechanical force between two adjacent wires carrying electric current is proportional to the product of the two currents; since in this case, when the same current is passing through both coils, the force is proportional to the square of the current. The force is also directly proportional to the angle of rotation of the torsion spring. Hence the value of the current is given by the formula:

$$C = K\sqrt{\theta};$$

where C = the current in amperes;
K = a constant depending on the construction of the instrument and the spring used;
θ = the angle of torsion required to keep the movable coil at zero.

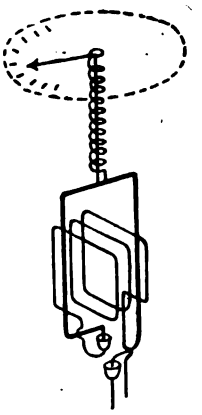

FIG. 1.

Fig. 1 shows a diagrammatic sketch of the instrument.

3. Give sketch to one-fourth full size of a switch for breaking an alternating current of 20 amperes at 2,000 volts.

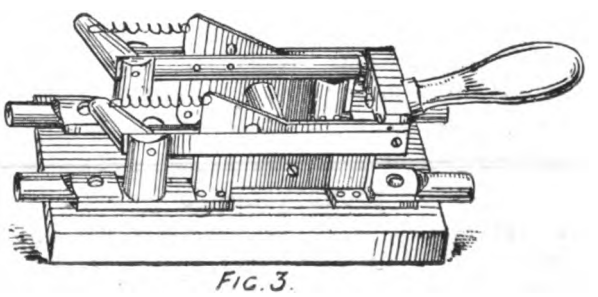

FIG. 3.

(To be continued.)

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TO CORRESPONDENTS.

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Vol. XIV. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers or binding can be obtained, price 2s.

UNACCOUNTED FOR.

The examination of the Huddersfield accounts for the year ending December 31, 1894, directs our attention to a subject which has often been discussed, but about which there are still great divergencies of opinion. We do not for one moment desire to suggest that Huddersfield is better or worse than other stations, but what we do want to impress upon our readers, and especially upon those connected with municipal supply, is the necessity of careful design and workmanship. Indeed, we think the greatest credit is due to the authorities at Huddersfield and elsewhere who have the courage to give the figures which enable us to get some idea of the losses incurred in central-station work. The aim of a central station is to sell or use all the current generated. Such perfection is, of course, impossible, and the next best thing is to sell the largest percentage possible of the current generated. Take the case of Huddersfield—always remembering that it is taken merely as an example, and for no other purpose—the cost of generating 265,146 units is £2,184. 5s. 5d., which gives a cost of 1·98 pence per unit. But 99,490 of these units are unaccounted for, leaving 165,656 units sold or used. There can be no revenue accruing from units lost, so we ought to take the cost of generation per unit sold, which with the figures given is 3·16 pence. Now, the smaller the losses, the nearer will these two costs approach, and one of the signs of good design and good workmanship is the smallness of the difference. The efficiency of any piece of machinery is recognised, so we may well recognise the efficiency of a combination in which is included management. We incline to the opinion that no station can be recognised as efficient unless the percentage of units sold is over 80. Losses, as we have said, are unavoidable, and 20 per cent. loss would be our limit as allowable, and this only under exceptional circumstances. It may be well to consider for a moment any exceptional circumstances which tend to increase the losses and to lessen the efficiency of the station. In the first place, the station efficiency for a few months more or less after commencing operations must generally be low. If we are dealing with an high-pressure system, transformers are installed, not with a view to the early work, but with a view to the average work; hence considerable losses may arise in the transformers. With regard to this, there comes in the question of design of transformer and its efficiency. If of good design, the losses are reduced to a minimum; if of bad design, the losses may be anything. In his book on "Alternate-Current Transformers," Mr. Weekes, discussing the question, says:

"The importance of reducing the iron loss will be seen when it is remembered that an average private house takes from five to twenty Board of Trade units per year per 8-c.p. lamp installed. If we consider a house having 120 of such lamps fixed, it might safely be supplied by the second transformer on the list. During the year it might take and pay for 13 units per lamp, or $120 \times 13 = 1{,}560$ units for the whole supply. But the transformer has 14·6 per

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cent. of iron loss, or wastes 545 watts continuously. Taken over the 8,760 hours in the year, this amounts to $\frac{545 \times 8,760}{1,000}$ units = 4,760 units. That means that four times the quantity paid for has to be generated. The efficiency of distribution is then $\frac{1,560}{6,320}$ = 24·6 per cent., neglecting the loss in the line. Now, if the iron loss were reduced to 2 per cent., which may be reasonably expected, the annual waste in the iron is then $\frac{75 \times 8,760}{1,000}$ = 655 units; so that, neglecting copper loss, the efficiency of distribution rises to 70 per cent. With other consumers, such as clubs and shopkeepers, the efficiency will be considerably over 90 per cent. if the load is steady for any length of time. The copper loss is important at full load, but decreases as the square of the current used, and so may be neglected at light loads. Thus, if the copper loss is 2 per cent. at full load it falls to ·5 per cent. at half load, ·125 per cent. at one-quarter full load, and to ·02 per cent. at one-tenth of full load. Hence, the regulation required does more to determine the copper loss allowable than the consideration of the actual waste in the copper circuits."

If now we have to deal with a low-pressure system, the principal loss will be in the mains, and this is easily calculable. There are other losses, such as leakage and so on, that might be considered, but these may wait another opportunity, enough having been said to point out the importance of the subject.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CITY AND GUILDS EXAMINATION.

SIR,—I beg to draw your attention to the answer which appeared in last week's issue of your journal to No. 6 question of the City and Guilds examination paper of 1894. The question is as follows: Current is required along a street 2,000ft. long at the rate of one ampere per 10ft. frontage. Give sectional area of conductor, so that the difference of pressure between *any two lamps* shall not exceed two volts in the following two cases—(*a*) the current being supplied at one end, (*b*) the current being supplied midway.

You will notice that I have italicised the words "any two lamps." I have done this, as I think you have overlooked them. In your answer you have taken the fall of potential between *each two* lamps to be two volts, and therefore the fall of potential for the whole 2,000ft. is equal to 400 volts. I feel sure that no examiner would set such an impracticable question as that. If you take the fall of potential between any two lamps—say, the first and last—to be equal to 2 volts, ∴ the resistance of the whole line = ·01 ohm.

$$\therefore \cdot 016 : \cdot 01 : : 1 : x,$$

$$x = \frac{\cdot 01 \times 1}{\cdot 016} = \cdot 625 \text{ square inch,}$$

which I think is the most probable answer. I do not think I need trouble you with corrections for (*b*), as, of course, they are of the same order.—Yours, etc.,

HENLEY L. HOWARD.

94, Stamford-street, S.E., April 29, 1895.

[We regret the error pointed out by Mr. Howard. Our contributor must have been working at some high frequency experiment when he proposed to light a street a third of a mile long by a No. 15 B.W.G. We would point out to Mr. Howard that he, too, has made a slip, and assumed that only one wire was required. The correct section is 1·25 square inches.—ED. *E. E.*]

WHAT, WHEN, AND WHERE.

Royal Institution, Albemarle-street, Piccadilly, W.

May 7, 3 p.m.—The third and last lecture on "Alternating and Interrupted Currents," by Prof. George Forbes, M.A., F.R.S., M.I.C.E.

Institution of Electrical Engineers.

May 9, 8 p.m.—At the Society of Arts, John-street, Adelphi, "The Recent Development of the Single-Acting High-Speed Engine for Central-Station Work," by Mark H. Robinson.

Iron and Steel Institute.

May 9, 10.30 a.m.—General meeting for presentation of report, etc. The president-elect (Mr. David Dale) will deliver his inaugural address, to be followed by other selected papers.

May 9, 7 p.m.—Annual dinner at the Freemasons' Tavern.

May 10, 10.30 a.m.—The following papers are expected to be read and discussed: 1. "On Metal Mixers as Used at the Works of the North-Eastern Steel Company, Limited," by Arthur Cooper. 2 "On the Hardening of Steel," by H. M. Howe. 3. "On Tests of Cast Iron," by W. J. Keep. 4. "On the Manufacture of Steel Projectiles in Russia," by Sergius Kern. 5. "On the Iron Ore Mines of Elba," by Herbert Scott. 6. "On the Effects of Arsenic upon Steel," by J. E. Stead.

Society of Arts, John-street, Adelphi, Strand.

May 6, 8 p.m.—Cantor Lecture by James Douglas on "The Recent Metallurgy of Copper, Lead, Gold, and Silver in America." Lecture III.

May 8, 8 p.m.—"The Extraction of the Rarer Metals from their Oxides," by Prof. W. Chandler Roberts-Austen, C.B., F.R.S.

Society of Engineers.

May 6, 7.30 p.m.—At the Town Hall, Westminster, "Street Subways for Large Towns," by C. Mason, A.M.I.C.E.

Institution of Junior Engineers.

May 3.—At the Westminster Palace Hotel, "The Warming of Buildings by Hot Water," by Ernest King, Whit.Ex., and Kenneth Gray.

THE EFFECTS OF ELECTRIC CURRENTS IN IRON ON ITS MAGNETISM.*

BY DR. J. HOPKINSON, F.R.S., ETC.

Let us recall a well-known experiment of Faraday's. Upon a ring of iron is wound a few turns of copper wire, through which may be passed a current. On it is also wound a second coil, the ends of which are connected to a galvanometer. It was known that when a current is passed through the first-named or primary coil, the ring becomes a magnet, and that if the current is reversed in direction the magnetisation is also reversed. Faraday showed that when the magnetism is reversed, a transient current is caused in the second coil. The current which is reversed is a measure of the magnetising force; the total amount of current caused in the second coil by the reversal is a measure of the induction of the magnet. The current in the second coil is opposed in direction to the current in the primary after reversal—that is, it is in the direction of the current before reversal. If the changes in magnetisation in the iron produce a current in the coil which is connected to the galvanometer, it is clear that they will also tend to produce a current in the coil which in like manner surrounds the magnet, and which has been connected to the battery. This current is what used to be known as the extra current. It continues for a short time the current in the battery coil in the direction which it had before reversal, and retards its change to

* Paper read before the Royal Institution.

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the opposite direction. If the battery which gives the current is a battery of many cells, and its extra E.M.F. is taken up by ordinary non-inductive resistances, there will be an E.M.F. in the battery to overcome these currents produced by the change of magnetisation, and the reversal of the current will be effected speedily. If, however, the number of cells is only sufficient to produce a current through the resistances of the electromagnet, the change will be much slower.

I have here an ordinary Westinghouse transformer which has an electromagnet in a ring form, but the iron of its core is divided into thin plates for the purpose of preventing currents in the iron itself. There is upon it a primary coil connected to the battery and a secondary coil connected to the galvanometer. I will first show you the effect produced when the battery current is produced by a battery of one cell giving about two volts. You observe that the current induced in the secondary coil takes a somewhat long time for its production and for its subsequent diminution—about 15 seconds. I will now connect it to a battery of high E.M.F., or rather to the mains which supply current to the building, and we will repeat the experiment with the same current in the primary coil. Observe the difference. The current increases more rapidly and dies away very much more quickly, taking in all about three seconds instead of 15 seconds, as before. I should perhaps here state that the sensibility of the galvanometer has been altered between the two experiments, so as to give a deflection of convenient size to be

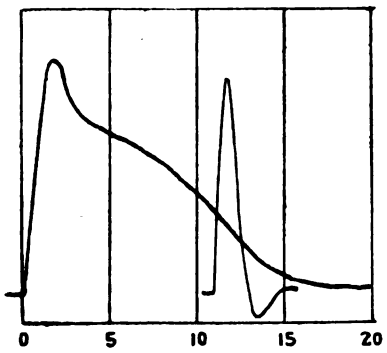

Fig. 1.

observed upon the screen. In the first case it is very much more sensitive than in the second. Exactly the same experiment can be shown to you in another form. These galvanometer deflections can be exhibited in the form of curves, in which the abscissæ represent times and the ordinates represent the deflections. The curve which I am showing you (Fig. 1) has actually been taken as a photograph, the plate being moved across the field with uniform velocity. On the same plate you see the curves which have been obtained with a larger E.M.F. and with a smaller one. The times at which the reversal occurred in each case are marked by the sudden change at the beginning of the curve. You see exactly the same thing as you saw upon the screen: the big battery makes the changes occur rapidly, the small battery allows them to occur more slowly. The dip of the curve for the large battery beyond the axes of the ordinates is not a real part of the phenomena. It is caused by the momentum of the moving part of the galvanometer.

In these experiments the iron has been divided in order to get rid of the particular effect about which I wish to speak this evening. Iron, as everybody knows, is a good conductor of electricity, not so good as copper, but still much better than any other substance than the metals. In a magnet, then, with a solid iron core, the outer portions of the iron are in a similar position to the copper coils surrounding the iron. On reversing the magnetising current, currents will be induced in the iron, and these currents will delay the changes of magnetic induction within them, and they will delay them the more the deeper in the iron is the point under consideration. I have in the room below a large magnet, which has been expressly constructed for the purpose of investigating the changes of induction which occur at different depths in the iron when the magnetising current is reversed. It is shown diagrammatically in Fig. 2. One view represents the vertical section of the magnet, the other the horizontal section. The magnet consists of a central cylinder of iron surrounded by an annulus with a large slab of iron at each end for the purpose of completing the magnetic circuit. Between the central cylinder and the annulus are placed the magnetising copper coils. In the solid cylinder holes are drilled at right angles to each other, and these holes meet within the iron. A strand of copper wire has been drawn in through the holes, and has subsequently been connected up so that the coils of the strand are in series with each other. In this way we have a coil surrounding a portion of the iron at 3, at 2, and at 1, of

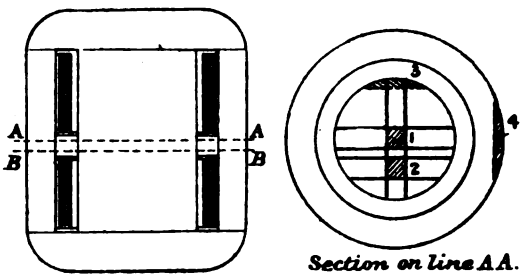

Fig. 2.

approximately the same area. If these coils then are connected to a galvanometer they will measure the changes of induction which occur in the areas 3, 2, and 1 enclosed, and we shall be able to show you the times at which the currents in the iron permit the effect of reversal in the copper coils to be manifest. We have, in addition, a coil, marked 4, in the outer magnet. Now, when the currents in the large copper coils are reversed, the magnetism or the induction in the coils 1, 2, 3, and 4 will also be reversed, but more slowly, and currents will be induced in these coils. I propose to show you the way in which these currents occur and are modified by the currents in the iron. We shall see that the changes in induction induce currents in the iron, and that these in their turn delay the changes in induction.

In order to give you a better idea of what is happening, we have provided three galvanometers. The galvanometers throw their images upon the screen at different altitudes. Now, what I want you to observe is this—that the disturbance of induction in the outermost coil occurs immediately

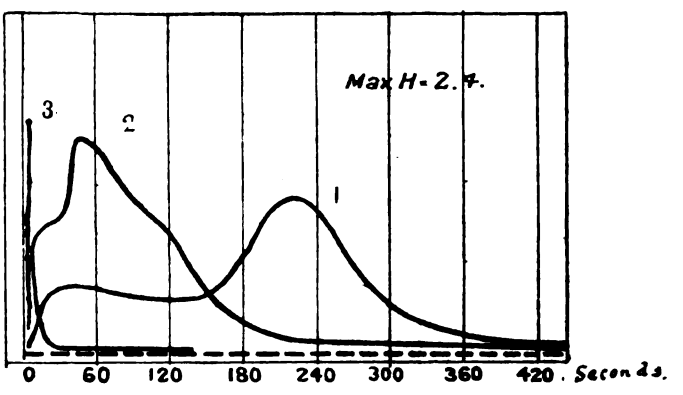

Fig. 3.

upon reversal of the current, and it occurs after some time in No. 2 coil, and after a much longer time in No. 1 coil, and also to observe the difference of the effects according as the magnetising current is large or small. In all these experiments a considerable battery power is used, and its excess of E.M.F. is taken up with non-inductive resistances consisting of lamps; that is in order to confine the effects to the currents in the iron, and to get rid as far as possible of the effects of induction in the copper coils themselves. We will begin with a somewhat low force, 2·4. You notice that, as shown in Fig. 3, the galvanometer of No. 3 coil is promptly deflected, and as promptly returns to zero, because there is no depth of iron outside it in which currents can circulate. No. 2 coil soon moves off to a substantial deflection, and presently, after 50 seconds have elapsed, it moves off to a greater deflec-

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tion. The behaviour of No. 1 coil is not dissimilar, but it takes much longer. As in the case of the transformer, the same thing can be shown as a curve (Fig. 3). Observe the relation of currents in the exploring coils to time. No. 3 coil rises to a maximum, and at once ceases. No. 2 goes off fairly rapidly, dwells for a time, and then rises to a full maximum at about 50 seconds; whilst No. 1

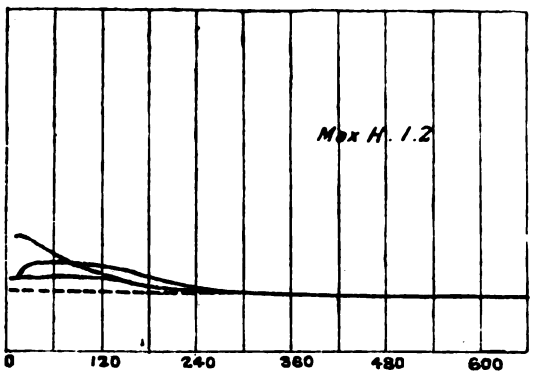

FIG. 4.

coil goes through the same events, but more slowly, as is shown by the increased abscissæ taking four minutes to reach its maximum. Here is a curve (Fig. 4) for a lower force, 1·2, half of the last: notice how great the difference—the maximum is reached much more speedily and the currents drop more slowly. Take a somewhat higher force, 6·0,

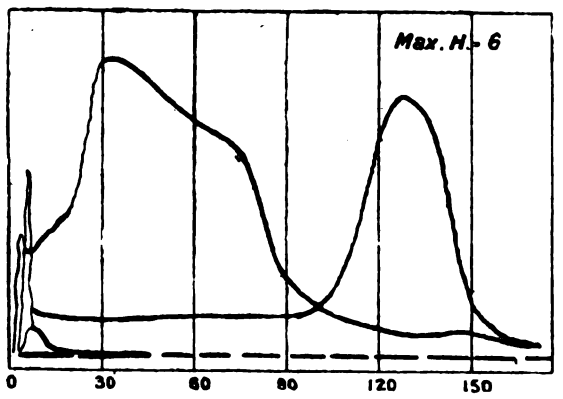

FIG. 5.

to see its effect on the galvanometers. The sensibility of No. 3 galvanometer is much less than that of Nos. 2 and 1, which are about the same. You see a new phenomenon develop: there is a first maximum in Nos. 2 and 1 coils, followed by a dwell and then a rise to a second maximum. Look at the corresponding curves

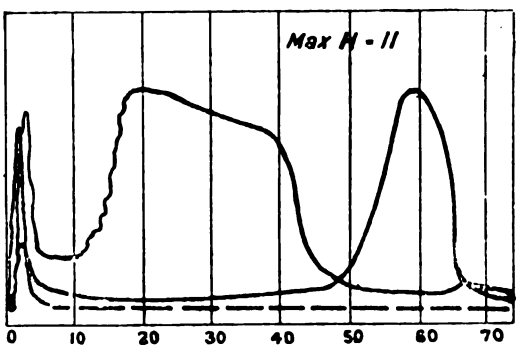

FIG. 6.

(Fig. 5). The maxima are occurring earlier than with the force of 2·4—that for No. 2 coil at 30 seconds instead of 50 seconds, and of No. 1, the centre coil, at 130 seconds instead of 240. Again take a higher force, this time 11 (Fig. 6): see how marked the first rise has become. On the curve notice that the maximum of No. 1 coil is as great as No. 2—with lower forces it has always been less. The highest force I shall show you is 24 (Fig. 7), and it is really the prettiest. The first maxima occur markedly at once. No 2 coil comes down to a small value, then rises to a substantial maximum in about 10 seconds, remains near its maximum value for 10 seconds, and passes away. Whilst No. 2 has been at its maximum, No. 1 has been quietly remaining undisturbed, and only when No. 2 has quite finished does No. 1 suddenly move off to a maximum

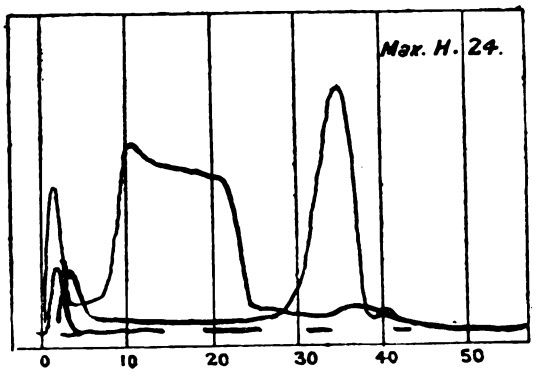

FIG. 7.

greater than No. 2 at 35 seconds and then very suddenly disappear. We must not leave this part of the subject without showing one experiment with No. 4 coil, which is placed in the annular part of the magnet. We will use the maximum force (24). The general character of the changes is the same as before, but in this case the mag-

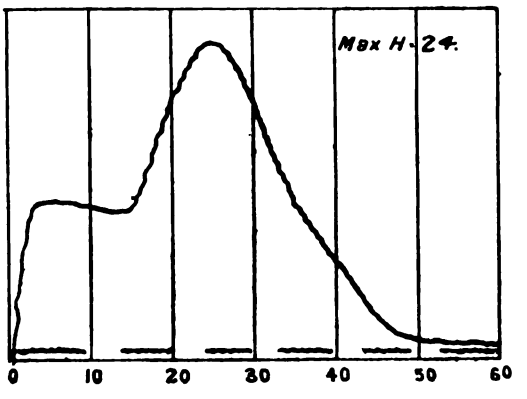

FIG. 8.

netism changes at once in the interior of the ring, and later at parts nearer to the outside. You see the same thing from the curve, Fig. 8.

I am afraid I can only give you a very general explanation of the peculiarities of these curves. I will first of all throw upon the screen a diagram (Fig. 9) showing what are known as cyclic curves of magnetisation. The vertical

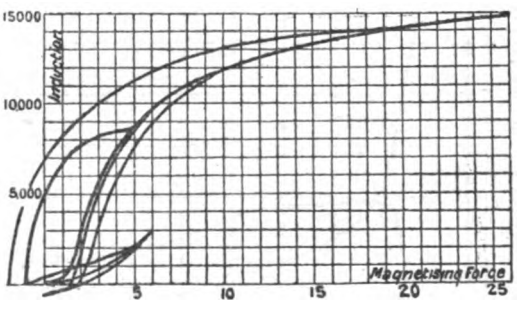

FIG. 9.

ordinates represent the induction, and the horizontal abscissæ the magnetising force. You will observe that when the magnetising force is small the ratio of induction to magnetising force is also small; that as the magnetising force increases this ratio is also increased for a time, but that, finally, it again becomes small. You will observe, further, that when the magnetising force is great the curve of magnetisation begins with a small rate of change, which

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then becomes large, and which again becomes finally small. Now, the slowness of changes of induction depends upon the largeness of the ratio of induction to magnetising force, and, therefore, we should expect that when this ratio is small the changes would occur with comparative rapidity, and that when it is large they would occur more slowly. This is exactly what we have seen. With a small force the change shows itself almost at once; with an intermediate force the principal maximum occurs much later, and with a large force it is continuously being accelerated as the force becomes larger. The first rise that occurs with a large force is due to the early part of the curve of induction, where changes of induction are comparatively small,

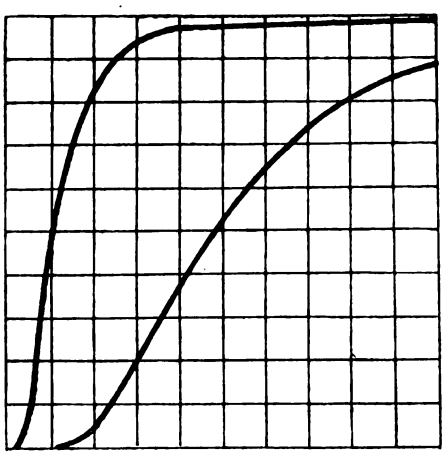

FIG. 10.

and where consequently the effects rush in rapidly. This first maximum is followed by a time of comparative quiescence, which is again succeeded by a second and large maximum caused by the full effect of the great changes of induction which have occurred, but which have passed in comparatively slowly; and then, finally, the change drops away to zero quite suddenly owing to the great rate at which the last part of the change has rushed in and pressed upon the parts which had occurred before it.

These phenomena of the times at which changes of induction occur in the cores of electromagnets have a close analogy to the retardation of signals upon cables. Many of you know if a battery is connected to a submarine telegraph cable, and if its connection is suddenly reversed, that the current throughout that cable is not reversed at once, but that it takes an appreciable time before the effect

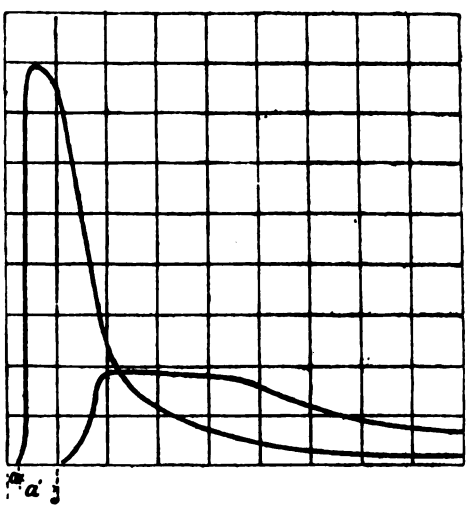

FIG. 11.

is perceptible at the far end of the cable. This retardation of the signal, as it is called, rapidly increases with the length of the cable. I will first of all show you two curves of arrival, as they are called, of the current in a cable (Fig. 10). In these curves the ordinates represent the currents, and the abscissæ represent the times. You will observe that there are two curves shown; one is for a length of cable double the other, the longer cable giving the slower times. Now, all that the curves in this form are capable of showing you is that with the longer cable the events are more retarded. In order to make them really comparable with the magnetic experiments, we must show a curve in which the abscissæ represent, not the currents, but the rate of change of current. We have such a curve here (Fig. 11). In this case the abscissæ represent the rate at which the current is changed, and the ordinates represent the time. This curve has a remarkable similarity to the magnetic curve with the lowest current. The similarity of the curves, as shown in Fig. 12, is quite sufficient to suggest an analogy between the phenomena which actually exist. I can show you the same thing in another way. There are in the library one of Lord Kelvin's syphon recorders, made by Messrs. Muirhead and Co., which will be at work after the lecture, and also an artificial cable, which has also been made by Messrs. Muirhead and Co. Curves can be obtained from the end and middle of the cable.

Magnetic experiments such as these have really a wide application. They are not restricted to the particular size of the cylinder upon which the experiment is made. If the cylinder is larger or smaller similar magnetic events will happen, but they will happen at times shorter or longer in direct proportion to the square of the linear dimensions of the cylinders—that is, to the areas of the cylinders. Hence we may boldly infer what will happen in magnet cores of dimensions too small to experiment upon or so large that they would be very costly to make. For example, suppose a core is made up of wires $\frac{1}{100}$th of an inch in diameter, we may expect that everything will go

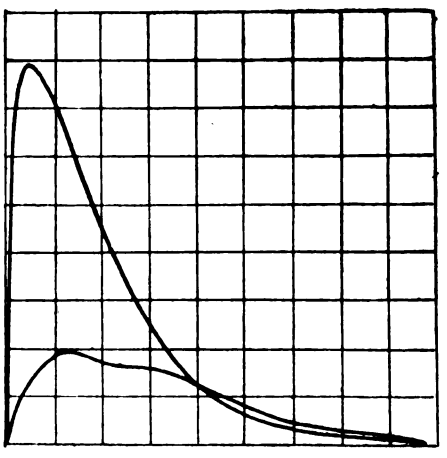

FIG 12.

on with the same currents around the core but 1,440,000 times as fast; with a force of 24, everything will be over at the centre of the core if the current is instantaneously reversed in $\frac{1}{40000}$th of a second.

One very practical application of these results is to the cores of transformers, but in this case we have not the sudden reversal of the magnetising current, but the current continuously varies from positive to negative and from negative to positive. It is not difficult to imitate these conditions on the slow scale which is suitable for our large magnet, but if I were to show you an experiment at an appropriate rate on the magnet which we used for reversals, I fear you would find the results intolerably tedious. It would take some minutes to get through a single reversal. I will, therefore, use a smaller magnet, 4in. instead of 12in. diameter, which will therefore get through the business nine times as speedily. I will first of all throw upon the screen a diagram (Fig. 13) which shows the method of the experiment. Here is the source of electricity, marked "dynamo"; here are resistances for regulating the current, marked "rheostat"; and here is a liquid reverser intended to reverse the direction of the current by continuous steps. It consists of two copper plates, to which the current is taken, and of two moving plates revolving between these plates, which plates are connected to the electromagnet. As the moving plates revolve, the current will diminish from a maximum in one direction to nothing, and will then increase to a maximum in the opposite direc-

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tion. The electromagnet is marked "magnet," the secondary coils of which are not indicated in the diagram. Only one coil in the centre of the magnet is connected. We will now turn the reverser faster. You see, the variations of inductions diminish greatly—indeed, the induction at the centre of the core is but little affected by the changing current in the magnetising coils (change leads). We might

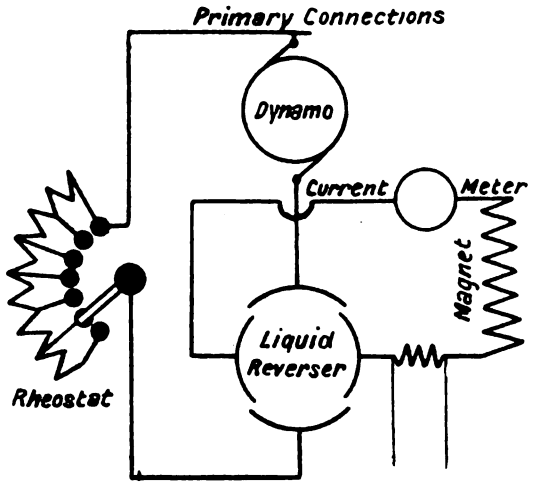

FIG. 13.

have tried three coils instead of one, but the experiment is a little confusing. If we had done so, we should have seen that the diminution of disturbance with increase of speed was less with No. 2 coil than with No. 1 coil, and that it had disappeared entirely with No. 3 coil, and we should further see that the current in No. 2 coil lay behind No. 3, and in No. 1 behind No. 2. I can show you the contrast more effectively with the Westinghouse transformer with

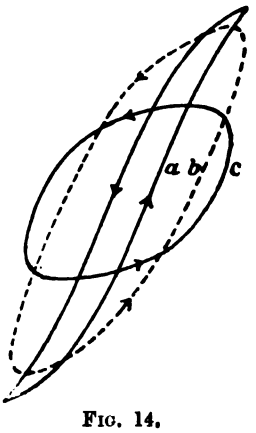

FIG. 14.

a divided core. This is now connected to the lowest galvanometer. We turn slowly; notice the deflection. We turn faster; you see the deflection is increased instead of diminished, as it was with the central coil of the solid electromagnet. Experiments such as these are at once applicable to transformer cores and the cores of dynamo machines. They show that in practice manufacturers have divided the iron about enough, and not too much.

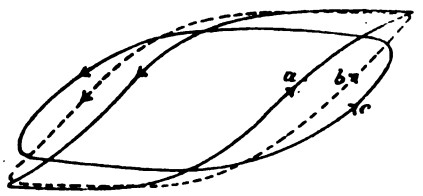

FIG. 15.

I have here on the table an instrument designed by Prof. Ewing for the purpose of describing the curves which express the relation between induction and magnetising force in iron. It served in Prof. Ewing's hands to illustrate the point which we have been discussing. I will throw upon the screen curves taken from Prof. Ewing's paper read before the Royal Society. The curves have been taken from solid samples of iron—I mean iron which is continuous, and not divided for the purpose of annulling the current in it. In the first curve (*a*, Fig. 14) we have the result in which the cycle has been passed through very slowly, and is the true curve of magnetisation. We have *b*, where the cycle has passed through in three seconds—and you will observe that the amplitude of the induction has diminished, and we have, lastly, the Curve *c*, where the period of the cycle is six-tenths of a second, and you will observe that it has much more diminished. This is owing to the fact that changes of induction in the centre of the iron hardly exist, and that therefore the total effect is materially diminished. The diagram (Fig. 15) is for steel. We have A, the natural curve of induction; B, the case when the period of the cycle is three seconds; and C, when the period is four-tenths of a second. Curves such as these, of course, very readily give you the average effects upon the whole mass of the iron. The curves which I have shown you give the particular effects of different parts of the mass.

In conclusion, let us indulge in a little wild speculation, not because it is probable that it is in any sense true, but because it is interesting. Suppose a magnet were made exactly like the one on which we experimented, but of the size of the earth, and that some mighty electrician generated such a current in its copper coils as would give a magnetising force of 2·5, and then reversed it, it would take some thousands of millions of years before the rate of disturbance at the centre attained its maximum value. The speculation I suggest is this: is it not conceivable that the magnetism of the earth may be due to currents in its material sustained by its changing induction but slowly dying away?

DEVIATION OF THE COMPASS.*

BY PROF. A. W. REINOLD, F.R.S.

By the deviation of the compass we mean the angle by which the compass needle errs from the magnetic meridian, or from the direction of magnetic north. On shore there is no deviation, nor is there on board a ship made of wood or other non-magnetic material. But iron is a magnetic substance, and on board an iron ship the compass needle is liable to be deflected from the magnetic meridian. The action of the iron is twofold: (1) some of it becomes permanently magnetised during the construction of the ship; (2) other is endowed with shifting magnetism, due to the changing position of the ship. The compass is affected by both causes, and there will generally be deviation; to what extent, and in what direction, depends upon a variety of conditions. Let me say at once that a magnetic needle on a compass card does not generally point exactly to the N.

A compass card is so balanced that it can only move on a horizontal plane; but that the earth's magnetic force is not entirely horizontal is shown by the fact that a magnet supported at its centre of gravity does not remain horizontal, but assumes a position in which its axis is inclined, in our latitude, at about 67deg. to the horizon. This angle is called the magnetic dip. The end of the magnet which points to the south is the end which is pulled down. The experiment of the dipping magnet tells us that the earth's magnetic fall is partly horizontal and partly vertical; the dipping needle, being acted upon by these two components, takes up a position which is neither horizontal nor vertical, but, in London, inclined at 67deg. to the horizon.

The apparatus which I have brought here for the illustration of our subject this evening consists of a skeleton binnacle, with the model of a ship's deck on the top. The whole can be turned about a vertical axis, the upper end of which is supported by a horizontal metal bar, with a recessed platform at the centre, which supports the compass. The binnacle is capable of carrying magnets and iron rods, horizontal and vertical, disposable in such a way as to imitate the magnetism of the ship and the various correctors. The compass consists of a small magnetised needle, attached at right angles to a glass, which carries a glass bulb and a mirror. The whole floats in water contained in a small glass cell. The stem has a small glass cup at the top, in which bears a steel point fastened to the lid. The buoyancy is such that the friction at the steel point is small. The advantages of the arrangement are sensitiveness, small friction, no torsion, considerable dead-beatness. A bar of unmagnetised soft iron becomes a magnet when submitted to the action of the earth's field. The maximum effect is produced when the bar is parallel to the lines of force in the earth's field—*i.e.*, parallel to the dip needle—but is nearly as great when the bar is held in a vertical position. The magnetism so acquired is only temporary, and disappears when the bar is held horizontally and perpendicular to the

* Abstract of a paper read before the Society of Arts, May 1.

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meridian. The bar is also magnetised temporarily when placed horizontal and in the meridian. If the bar be again placed vertical and struck a few times with a mallet, the magnetism now acquired is greater than before, and is to some extent retained. Let the bar be now inverted. The end which was before uppermost is now below. The effect produced on the test-needle is due to the difference between its retained and its temporarily acquired magnetism. That the retained magnetism is not permanent is shown by striking the bar in its new position. It may again be restored to the neutral or non-magnetic condition by a few blows when it is held horizontal and near the meridian.

The effect of twisting an iron rod or wire in a magnetic field is similar to that due to percussion. But if the iron is soft the acquired magnetism is soon got rid of. Suppose that similar experiments were made on a bar of hard iron—*i.e.*, on iron partaking more or less of the character of steel—we should find the inductive action of the earth decidedly less than in the case of soft iron or mild steel; the effect of hammering would not be so marked. But the magnetism acquired by hard iron when submitted to long-continued and violent hammering, such as the plates of a ship receive when riveting, etc., during the construction of a ship, is very difficult to shape out. A large proportion of it is practically permanent. We thus see how a ship becomes a permanent magnet. Each plate, or rib, or beam, each bulkhead or watertight division, remains in a fixed position while heavy blows are poured upon it. The iron ship becomes a huge magnet.

I spoke of the effect of an iron ship on a compass on board as being twofold—viz., that due to the permanent magnetism of the ship, and that due to temporary induction in soft iron. We have now to consider the second of these, and in doing so we will take in order the action of the west and horizontal components of the earth's magnetism. Every vertical mass of iron in the ship—the ship's sides and ribs, fore and aft and transverse compartment divisions, masts, funnels, etc.—will be magnetised with (in these latitudes) north at the top and south at the bottom. If all the iron is symmetrically disposed with regard to a central vertical fore and aft plane, it may, so far as its action on the compass is concerned, be supposed to be replaced by a single vertical rod with one of its extremities in the fore and aft line through the compass. Whether this imaginary resultant rod is foreward or aft of the compass will depend upon where the compass itself is placed on the ship. The effect on the compass of all the vertical iron is then the same as that of a single vertical iron rod in the fore and aft line through the compass. As the ship swings completely round this will produce a complete error of precisely the same character as that we have already considered—viz., semicircular.

The next point to consider is the action on the compass of magnetism induced in the iron of the ship by the horizontal component of the earth's magnetism. There is ordinarily a large mass of soft iron in a ship in which horizontal induction can take place; but whatever its disposition, provided it be symmetrical, with regard to the fore and aft line, its resultant effect on the compass may be considered as due to, and may be represented by, iron rods, in the plane of the compass, and in the fore and aft and transverse lines through the centre of the compass. Such rods will produce no compass error when the ship is magnetic north and south, or magnetic east and west. But in intermediate positions the induced magnetism will deflect the needle, and if the error is easterly when the ship's head is in the north-east quadrant, it will also be easterly when the ship's head is in the south-west quadrant, and will be westerly in the other two quadrants. This error is called quadrantal, because it changes sign in every quadrant. If easterly, with the ship's head in the north-east quadrant, it is said to be positive. Isolated rods in the fore and after line produce positive and in the athwartship line negative quadrantal error. This suggests a mode of correcting the error by employing masses of iron, generally spheres, tolerably close to the compass. If the error is positive, the spheres must be placed port and starboard of the compass; if negative, in the fore and aft line. We have supposed the iron of the ship to be symmetrically arranged with respect to the fore and aft vertical plane through the compass, and though this is generally the case, it is not necessarily so. There may be a mass of iron—say, an iron pinnace or launch—stowed on one side of a ship in the neighbourhood of the compass not balanced by an equal mass on the other side. Such unsymmetrically-disposed iron gives rise to a quadrantal error, which is a maximum at the cardinal points, and sometimes also to a small constant error—*i.e.*, one whose magnitude and symmetry are independent of the direction of the ship's head.

We have thus brought under view the various causes producing compass error on board an iron ship. They are summed up in the formulæ—

$$\delta = A + B \sin \alpha + C \cos \alpha + D \sin 2\alpha + E \cos 2\alpha,$$

in which δ = the deviation, when α = the compass course; A, B, C, D, E are the coefficients; A is the constant coefficient; B and C are the fore and aft and transverse components of the semicircular error; D and E refer to the quadrantal error, D being due to symmetrical and E to unsymmetrical iron; A and E may generally be neglected.

The method of compensation now universally adopted was first employed in a systematic manner by the late Sir George Airy, and has been brought to its present state of efficiency by Lord Kelvin. The formulæ show us that there are only three components of the error with which we have to deal—viz., B, C, and D, B and C referring to semicircular and D to quadrantal. B arises from fore and aft magnetic forces, due to vertical iron and permanent magnetism of ship; C from transverse forces, due to permanent magnetism only. The component C can be corrected by permanent steel magnets, placed in the binnacle at a suitable depth below the compass. Similarly B, if it were due to the permanent magnetism of the ship only—*i.e.*, if inaction in vertical iron had no part in producing it—might be corrected by fore and aft magnets suitably placed in the binnacle. But if part of B is due to vertical iron, that part ought to be corrected by vertical iron, and the remainder only by magnets. The difficulty is to know how much of the observed error is due to each of the above causes, and this one cannot know until observations have been taken in two widely different latitudes. On the magnetic equator there is no vertical force, and therefore the whole of B observed on the magnetic equator must be due to permanent magnetism, and should be corrected by steel magnets. If on board such a ship, sailing northwards from the equator, B should be found to have a sensible and increasing value, we should know that it was due to vertical induction only, and we should correct it by vertical induction—*i.e.*, by placing a vertical rod of iron of suitable length close to the binnacle, either forward or aft of it, so that its effect should just balance that of all the vertical iron of the ship. Such a rod is called a Flinders bar. As used in Lord Kelvin's binnacle, it is 24in. long and 3in. in diameter, and is made up of pieces, the longest of which is 12in. long and the shortest $\frac{3}{4}$in. We have thus by permanent magnets, Flinders bar, and the quadrantal spheres balanced every cause of compass error, and compensation thus effected will hold good for all latitudes, so long as the ship remains on an even keel.

HEELING ERROR (STANDARD COMPASS).

Ship Built in Great Britain, and Heeling (in N. Latitudes) to Starboard.

Causes.	Symbol.	Direction of error.	Error a maximum.	How compensated.
Principal.				
1. Transverse horizontal beams becoming inclined. Induction by earth's vertical force	e	To windward.	When ship's head is N or S varies, as cos α = azimuth of ship's head measured from N. by compass	Partly by "quadrantal" spheres
2. Iron perpendicular to deck vertically below compass..	k	Windward.	N or S.	By magnet or magnets, red pops upwards (generally) placed vertically in binnacle below compass.
3. Force perpendicular to deck due to ship's permanent magnetism	R	Windward (generally).	N. or S.	
Subsidiary.				
4. Iron perpendicular deck *not* vertically below compass..	c	To E.	E. of W. $\alpha \sin^2 \alpha$.	Flinders bars.
5. Horizontal fore and aft iron	g	To W. if compass is near stern of ship; to E. if compass near bow	N. or S. $\alpha \cos^2 \alpha$.	Compensation not generally attempted.

The table exhibits in a tabular form the principal and secondary causes of heeling error, the direction of the error in each case, the direction of the ship's head when the error is a maximum, and the mode of compensation. We will not here

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trouble ourselves about the subsidiary causes, but in the case of the others it is clear (1) that generally the error is to windward, (2) that it is a maximum when the wind lies north and south, and vanishes in the east and west direction. Next, with regard to compensation. Errors 1 and 2 are caused by vertical induction in iron, and should be similarly compensated. And to a certain extent they are so; for consider the iron spheres which correct the quadrantal error. These would by themselves produce a heeling error to leeward, and therefore act against the other causes. The amount of negative error produced (or positive error compensated) may be calculated when the size of the spheres and their distance from the compass are known, and the value so deduced agrees fairly well with that experimentally observed. The spheres correct from five to seven minutes of heeling error, per degree of heel, for each degree of quadrantal error they correct. Thus, suppose the quadrantal error to be 11deg., the 8½in. spheres by which this is corrected would by themselves produce a heeling error to leeward of about 1deg. (per degree of heel), and will therefore correct an error of 1deg. to leeward.

The remainder of the error—which may be the principal part—is corrected by permanent magnets, one, two, or three in number, placed in a brass tube which can slide up and down a vertical central channel in the binnacle. The empirical method of correcting the error, and at first sight the simplest, would be, assuming there is no error on an even keel, to place the ship N. and S., cause and maintain a certain heel (say to starboard) of 10deg., place magnets with red poles upwards in the receptacle provided for them, and raise or lower them until the error disappears; but owing to the difficulty and expense—especially with large ships—of actually heeling the ship, this method is not employed. One of the plans generally adopted—the simplest of them—is to determine the vertical magnetic force on shore by means of a suitable dip needle. The latter is then brought on board, placed in the binnacle (the compass bowl having been removed), so that the dip needle occupies the same position as the compass needle. The vertical connecting magnets are then raised or lowered until the vertical force on board is equal to that on shore, modified by the application of a small correction on account of the screening action of the iron of the ship. The dip needle has a sliding weight attached to it. This, in the experiment on shore, is moved until the needle is horizontal; in this case the mechanical couple, due to the earth's vertical force, is balanced by the leverage of the sliding weight. On board, the vertical magnets are moved until the horizontal position of the needle, which will probably have been disturbed, has been restored. The error is now corrected.

In the method of correcting the semicircular and quadrantal errors of the compass which I have described, it is necessary that the true magnetic bearing of some object visible from the ship should be known, so that the ship may be placed successively magnetic north and south, and magnetic east and west. It is possible, however, to completely correct the compass when nothing is visible outside the ship—*e.g.*, in a fog or at night. The correction is effected by means of an instrument called a deflector. On the table are two forms of the instrument, one Lord Kelvin's, consisting of two magnets hinged together at their extremities, the free ends being adjustable at a greater or less distance apart. The other form has been designed by Dr. Waghorne, assistant professor of physics at the Royal Naval College, Greenwich. It consists of two short parallel magnets, movable up and down a movable stem by a rack and pinion arrangement.

The mode of procedure is as follows: Put the ship's head north by compass and keep her there by means of an auxiliary compass. Place the deflector on the glass cover of the compass bowl, and arrange it so that the compass card is turned round through 90deg. Lord Kelvin keeps his instrument in a fixed position on the bowl, and adjusts by altering the distance between the poles of the deflector magnets; this can readily be done by means of a double screw. Dr. Waghorne, on the other hand, rotates his deflector, without altering the position of the magnets on it, until the deflection of 90deg. is obtained, and reads off the angle (say α) the deflector makes with the compass needles. Similar experiments are made with the ship's head south by compass, and another angle, β, is read off. The deflector is now set on an angle whose sine is the mean of the sines of α and β, and fore and aft magnets introduced into the binnacle until the deflection of the card is again 90deg. The fore and aft component of the semicircular error—so far as it is due to permanent magnetism only—is now compensated. In an exactly similar way, by taking observations with the ship's head successively east and west, the transverse component can be corrected.

The use of these instruments, though requiring care and patience, is not by any means difficult, and is soon learnt. Further, by the sine-deflector, it is possible, without disturbing or altering any correctors in the binnacle, to determine the coefficients, B, C, and D, and so to supply the means of computing the error on any compass course. This use of the deflector may be valuable in cases where it is undesirable to interfere with the correctors.

PHYSICAL SOCIETY.

An ordinary meeting of this society was held on April 26, Mr. Walter Baily, vice-president, in the chair.

Prof. S. P. Thompson read a note on "**A Neglected Experiment of Ampere.**" Ampère, in 1822, made an experiment which, if it had been properly followed up, must have led to the discovery of the induction of electric currents nearly 10 years before the publication of Faraday's results. While attempting to discover the presence of an electric current in a conductor placed in the neighbourhood of another conductor in which an electric current was flowing, Ampère made the following experiment. A coil of insulated copper strip was fixed with its plane vertical, and a copper ring was suspended by a fine metal wire so as to be concentric with the coil and to lie in the same plane. A bar-magnet was so placed that if an electric current was induced in the suspended ring a deflection would be produced. No such deflection, however, was observed. In 1822, in conjunction with De la Rive, Ampère repeated this experiment, using, in place of the bar magnet, a powerful horseshoe magnet. He describes the result in the following words: "The closed circuit under the influence of the current in the coil, but without any connection with this latter, was attracted and repelled alternately by the magnet, and this experiment would consequently leave no doubt as to the production of currents of electricity by induction if one had not suspected the presence of a small quantity of iron in the copper of which the ring was formed." This closing remark shows that they were looking for a permanent deflection. When, however, Faraday's results were published in 1831, Ampère, after again describing the experiment made in 1822 by himself and De la Rive, says: "As soon as we connected a battery to the terminals of the conductor the ring was attracted or repelled by the magnet according to the pole that was within the ring, which showed the existence of an electric current produced by the influence of the current in the conducting wire." Verdet, when describing the above experiment, falls into a curious error. He says the apparatus consisted of a ring of fine copper wire suspended by a silk thread in front of the pole of an electromagnet in such a way that the plane of the ring was parallel to the plane of the turns of wire on the electromagnet. On making the current the ring is said to have been repelled, but this deviation did not persist, and on "breaking" the current the ring was attracted, also only momentarily.

Mr. Blakesley did not feel quite confident that in Verdet's form of the experiment there could ever be attraction. He also pointed out that with an alternating current the disc would tend to set itself parallel to the lines of force of the electromagnet. With reference to repulsion by alternating currents in one of Elihu Thomson's experiments, where a sphere is supported over an alternating pole, a screen being placed so as to partly shield this sphere, there is generally a mis-statement as to the direction in which the sphere rotates. It rotates in such a direction that the part of its surface next the magnet moves towards the edge of the screen.

Dr. Burton said that from the fact that when the current in the electromagnet in Verdet's experiment is broken, the induced current in the ring is in the same direction as the current in the magnet, and the ring will be attracted.

Mr. Boys confirmed Dr. Burton's statement. He recommended setting the ring at an angle of 45deg. to the lines of force, under which circumstances a rotation would be obtained. A distinction must, he pointed out, be drawn between such an experiment as that of Verdet's and those of Elihu Thomson's. The repulsions observed in these latter were only due to the "lag" in the induced currents caused by self-induction. The best materials to use for all such experiments were magnesium and aluminium, since for a given mass these had the highest conductivity.

Mr. W. G. Rhodes read a paper entitled "**A Theory of the Synchronous Motor.**" The object of this paper is to give as simple a treatment as possible of the mathematical part of the subject, and to give theoretical proofs of some experimental facts. Starting from the energy equation—

$$p + c^2 R = C E \cos \Psi,$$

where p is the output of the motor, R the resistance of the armature, c the current through the armature, E the E.M.F. applied to the motor terminals, and Ψ the phase difference between c and E, the cases of maximum output, zero output, minimum current at zero power, and maximum phase difference between c and E are considered. These results are for the most part obtained directly from the energy equation. The latter part of the paper is devoted to a discussion of the phase relationships between the current and the E.M.F.'s in a plant consisting of a generator and motor, and to the variations in the armature reactions in both generator and motor. A theoretical proof is given of the fact, observed by Prof. Silvanus Thompson and others, that an over-excited synchronous motor acts as a condenser, and tends to make the current lead before the generator's E.M.F.

Prof S. P. Thompson said that the mathematical part of the paper was much simpler than that in previous investigations on this subject, and the method of arriving at the results by rejecting imaginary roots of the equations was particularly neat and instructive. The part of the paper relating to armature reactions and phase relationships was quite new. Two results deserved special attention: first, that the maximum current at zero power was the same as if the circuit was non-inductive; second, that the maximum current at zero power was double the current corresponding to maximum output.

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Mr. Blakesley said that the paper did not consider the stability of the system, and he thought some of the results corresponded to regions of unstability.

A paper by **Mr. Bryan** "**On a Simple Graphical Interpretation of the Determinantal Relation of Dynamos**" was, in the absence of the author, read by Dr. Burton. The relation is worked out for two specially simple systems, possessing one degree of freedom: (1) a particle moving in a straight line with uniform acceleration; (2) a particle moving to and fro along a straight line with an acceleration directed towards a fixed point on the line, and proportional to the distance from that point (simple harmonic motion). On constructing a diagram in which the abscissæ represent values of the single co-ordinate of the particle, and the ordinates corresponding values of the momentum, the determinantal relation becomes equivalent to the constancy of the area of a certain elementary parallelogram. In case (1) this parallelogram moves along a parabola, experiencing a shear as it goes, while in case (2) there is no distortion, the (rectangular) parallelogram revolving about the origin of the diagram as if rigidly attached to an inextensible radius vector.

THE SELECT COMMITTEE ON TELEPHONY.

The Select Committee of the House of Commons which is engaged on an enquiry into the sufficiency of the telephone service met again on Friday, Mr. A. Morley presiding.

The evidence of **Mr. Dickinson**, deputy-chairman of the London County Council, was resumed. He stated, says the *Times*, that the general tendency of the charges contemplated in the agreement between the Post Office and the National Telephone Company was to increase the trunk charges. The Council also felt that exception might be taken to the clauses which contemplated that where a message was sent from the National Telephone Company's office in London to the office of another company in another town a terminal charge should be made. The only remedy he could suggest was that competitors should be put on an equal footing with the National Company. The scarcity of subscribers in London he attributed to two facts—first, that the service was bad; and secondly, that the charges were very high as compared with the charges made in continental cities. The committee of the Council which was appointed to look into the question had received three reports from three separate engineers, and those reports showed that London could be telephoned now for 10,000 subscribers at a subscription of something under £10 a year. The reports dealt with the area of the county of London. Witness then dealt with the National Company and the old United Company in detail. At the time of the amalgamation the United Company was paying something like 15 per cent. on its capital. The capital had since been largely increased. Competition was the best way of developing the telephonic service, as long as it was not taken over by the Government. If the Government did not take over the telephones he would permit the municipalities to do so. The London County Council was not prepared with any specific allegations of imperfect service by the National Telephone Company.

Sir E. H. Carbutt, representing the London Chamber of Commerce, was next called. He said that he was chairman of the engineering and allied trades section of the Chamber, and was a member of the committee of the council specially appointed to consider the question of the agreements. The Chamber adopted a series of resolutions on the subject. One was in favour of State acquisition, a second was in favour of letting matters alone, in view of Sir W. Harcourt's statement in the House of Commons, and a third was in favour of encouraging properly-controlled competition. The Chamber, said the witness, regarded the telephone as being in its infancy, and believed that with proper facilities it would prove of immense assistance to trade. As to "varying rates for limited service," the idea was that others besides the rich might be enabled to use the telephone if communication were established in small areas. Persons might, for instance, be put in communication with the local tradespeople; and in the case of agricultural districts, a number of farms might be connected with the creamery which they served. The cost of making such a telephonic connection would not be more than £100 for about 10 farms. This work could be done by small companies, and the Postmaster-General would control competition in the interests of the public. London ought to be dealt with on a separate basis from the rest of the country. If competition were permitted, some standard regulations, applicable to all towns, should be drawn up.

Major Flood Page also gave evidence as to the resolution passed by the London Chamber of Commerce. He said that they were the result of a long discussion, and represented the compromise of widely different views.

The committee adjourned, after sitting for some time with closed doors.

The Select Committee sat again on Tuesday, Mr. Arnold Morley presiding.

Mr. Berridge, chairman of the Street Committee of the Commissioners of Sewers of the City of London, said that the present service was very inefficient in consequence of the lines being frequently blocked. He paid £17 a year under a five years' agreement. He was authorised to say that the Commissioners of Sewers were very anxious to get a good service at a reasonable rate, and a resolution had been passed by his committee to the effect that £10 a year would be a reasonable rate. The Commissioners had been in negotiation with the City of London Electric Lighting Company for the use of their tubes by a company that would supply a service at a reasonable rate, and those negotiations were still going on. The Commissioners of Sewers were the road authority in the City and had control of the streets, and that control ought to be maintained. He thought the Commissioners ought to have the right to apply for a license if they thought fit to do so, but as far as he knew it was not now their intention to apply. For his own part he would like to see the telephones taken over by the Government. If a license were granted to the London County Council, he should certainly say that the Commissioners would not hand over to them the control of the streets.

Mr. John Archibald Dow, a coalmaster in Glasgow, said he had used the telephone in that city for 11 years, and had always found it a very good service, though there were occasional breakdowns. To give municipalities licenses was, in his opinion, a retrograde step. He would rather see all the telephones in the hands of the Government. His subscription was £10 a year. He came to give evidence at the request of the National Telephone Company.

Mr. Robert Caird, superintendent of the Glasgow Omnibus Company, also expressed general satisfaction with the service at present, and deprecated the granting of a license to the Corporation.

Mr. James Patterson Waldie, a partner in a firm of coal-owners, and **Mr. Alexander Risch**, editor of an Edinburgh evening newspaper, expressed themselves as well satisfied with the efficiency of the present service in Edinburgh; and **Mr. Alexander Hay Moncur**, ex-provost of Dundee, and **Mr. James Crombie**, a merchant and shipowner of Aberdeen, also gave evidence in favour of the existing service in Dundee and Aberdeen respectively.

LEGAL INTELLIGENCE.

WYNNE v. HASLAM AND CARTWRIGHT.

This case, which lasted two days, was tried last week at the Liverpool Assizes. The action was one of a personal nature, but is nevertheless of importance to municipalities and their officials. The plaintiff was Mr. William Richard Wynne, formerly electrical engineer for Bury, and the defendants were Mr. John Haslam, town clerk of Bury, and Mr. Joshua Cartwright, the borough engineer. The defendants had the support of the Corporation, the Mayor and Electric Lighting Committee strongly supporting the course they had adopted.

It appears that somewhat strained relations had existed for some time between Mr. Wynne and other officials, due to the objection of the former to submit himself to the latter, as the Corporation considered he should do. The upshot was that Mr. Wynne received a month's notice. This led to the relations becoming more strained, and Mr. Wynne felt aggrieved because he was locked out of a room. Incidents then occurred which led to the present action. Mr. Wynne at the last assizes raised an action against the Corporation for wrongful dismissal, and received damages, and now proceeded against the gentlemen named above.

Mr. Pickford, Q.C., in his opening statement for the plaintiff, said that this was an action for damages against the two defendants, arising out of the engagement of the plaintiff by the Bury Corporation, and the dismissal of the plaintiff by the Bury Corporation from his position of electrical engineer of the Corporation. Mr. Haslam was the town clerk of Bury, and the defendant Mr. Cartwright was the borough surveyor. The cause of action was threefold. In the first instance, Mr. Wynne claimed damages against both defendants for having maliciously induced the Corporation to terminate his employment as electrical engineer to them. The defendants said, shortly, that they did nothing of the kind. Then, as to the action against Mr. Cartwright, the plaintiff said he slandered him, and spoke defamatory words of him to the Electric Lighting Committee of the Council, who were the immediate employers of the plaintiff. The words complained of were that Mr. Cartwright had at the committee meeting said that it had been found necessary to lock up Mr. Wynne's room, and the counsel submitted that to Mr. Wynne had been imputed conduct which obliged him to lock him out of the occupation of the room. The defence which Mr. Cartwright set up was that he was privileged on the occasion—that was to say, that an official was speaking to the Electric Lighting Committee of the Corporation; that if he spoke *bona fides*, even although what he might say was inaccurate, he would be protected With regard to the assault (the cause of complaint against Mr. Haslam), the plaintiff was in Mr. Cartwright's room, and the town clerk turned him out. The plaintiff said whether the town clerk did right or not, he certainly did it with too much violence.

The defence was conducted by Mr. Russell and Mr. McCall.

Mr. Justice Hawkins, in summing up, stated that it was regrettable that the action should have been brought. He pointed out that Mr. Wynne was attracted by an advertisement to make application for the post of electrical engineer to the Bury Corporation, but the Bury Corporation had in their employ at that time Mr. Cartwright, who was their surveyor, and who had been with them for 15 or 16 years, and had served them faithfully at the head of his own department. When he entered the service of the Corporation, Mr. Wynne may have entertained the notion that he was to have an equal position with that of the old surveyor, but certainly that was not their intention. Their intention was that Mr. Wynne, although placed in a responsible position in their service, should be below in point of position the surveyor who

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had been trusted by them for 15 or 16 years, that he should have a subordinate place—not, indeed, to be in the position of a mere clerk—but that he was to be under the surveyor and under the surveyor's directions. There was early in the engagement discussion as to whether or not Mr. Wynne would be prepared to go on, whether he would act in a subordinate position to the surveyor, and there was a very decisive answer in the negative on the part of Mr. Wynne that he would not do so. However, he did go on as far as he could, reluctantly and unwillingly serving the Corporation, and, as far as he could bring himself to do so, submitting to the authority of the surveyor, until about the month of October, when these final differences occurred between them, and he was dismissed from the service. The judge stated that Mr. Wynne should have acted harmoniously with the other officials, and left it for the jury to decide upon the three issues before them.

The jury returned a verdict for the defendants on the first two counts, and on the third count (that of assault) a verdict for the plaintiff of 40s. damages.

Mr. Russell asked for judgment for the defendant on the record as it stood, to which Mr. Justice Hawkins assented.

The real question at issue was whether an official holding a subordinate position under a municipality should or should not be subordinate to a superior official. The verdict has been to the former effect, and it is satisfactory to note that the Bury Corporation have supported their town clerk and borough surveyor in this affair.

ACTION TO RECOVER CALLS.

Before Mr. Justice Wills, the three cases have been heard of the London Metallurgical Company *v.* Sherrard O. Cowper Coles; same *v.* Sir B. W. Walker; and same *v.* Samuel Hood Cowper Coles. The question involved was as to the liability of holders of certain shares to pay calls, the three actions being brought by the liquidator of the plaintiff company. The Metallurgical Company was incorporated on December 8, 1890, and an order for its winding up was made on May 18, 1893, a liquidator being appointed on September 21, 1893. The first-named defendant was an engineer and an inventor, and in August, 1891, he was allotted 275 shares of £10 each, fully paid up, in the plaintiff company in respect of certain patents which he transferred to them. The agreement between the parties in regard to this transaction was never registered. On December 9, 1893, notice was given by the liquidator to Sherrard Cowper Coles of the settlement of the list of contributories. That list was settled on January 31, 1894; on February 6, 1894, notice was given to him of it, and on May 29 there was an order for the liquidator to make a call, of which due notice was given. The first defendant retained 108 shares, for which it was now sought to fix him with a liability for calls, they being treated as vendors' shares. Objection was taken on his behalf that the companies winding-up rules had not been complied with; but this contention was abandoned, the defence relied upon being that he was allotted the shares fully paid up as consideration for patents in respect of which he had never been paid, and that if the liquidator were now to be allowed to dispose of the patents, then the defendant had a lien on them, and he set up a counter-claim in their regard. The defendants in the second and third actions were brother-in-law and brother respectively of the first defendant, Sir W. B. Walker being a naval officer. They were simply transferees for value, and they had no notice whatever at the time of the transfer of the shares that there was any liability whatever upon them, but they took them as fully paid up. On the other hand, stress was laid on the fact that the agreement between the first defendant and the company was not registered, and on this account, it was said, the company endeavoured to escape from its obligations to pay the first defendant for the patents he had transferred to them.

At the conclusion of the arguments his **Lordship** gave judgment in the first action for £1,080 for the plaintiff, and decided that the defendant had no lien on the patents. In the second action he gave judgment for the plaintiff for £30, without costs, and in the third judgment for the plaintiff for £50, with costs.

COMPANIES' MEETINGS AND REPORTS.

EASTERN EXTENSION TELEGRAPH COMPANY.

The forty-third ordinary general meeting of the shareholders of this Company was held on Wednesday at Winchester House, Old Broad-street, under the presidency of Sir John Pender, M.P.

The **Chairman**, in moving the adoption of the report and accounts, said that the gross receipts for the half-year were £261,322, against £251,689 for the corresponding period of 1893, the increase being entirely due to the large Government and Press traffic carried on with China and Japan since the commencement of hostilities between those two countries. The working expenses for the half-year were £89,740, against £76,574 in the corresponding half-year of 1893. Of that sum nearly £9,000 was due to the increased cost of repairs and the maintenance of cables, while the balance of the increase was due to the opening of new stations and the establishment of electric lighting at various other stations. Comparing the figures for the whole of the year with the previous year, their gross receipts for 1894 were £509,003, against £509,684 in 1893; while their working expenses were £170,035, against £154,803. The usual interim dividend had been declared, and, with the balance they proposed to pay after that meeting, they would have declared a dividend for the year of 5 per cent. In addition to that they proposed to pay a bonus of 4s. per share, equal to another 2 per cent., making a total dividend for the year of 7 per cent. A balance of £89,686 was carried to the general reserve fund, which now stood at £641,598, after charging the past year with £100,000 in part payment of the new Singapore and Hong-Kong cable.

The **Marquis of Tweeddale** seconded the motion, which was put and unanimously adopted.

Mr. C. W. Earle and Mr. G. G. Nicol (the retiring directors) were reappointed, as also were Messrs. Deloitte, Dever, and Co., and Messrs. Welton, Jones, and Co. as auditors.

NORWICH ELECTRICITY COMPANY, LIMITED.

The annual meeting of the shareholders of this Company has been held in Norwich to receive the report of the directors, which was as follows: The directors have much pleasure in presenting their third annual report, which shows the great progress and increasing prosperity of the Company. They consider it highly satisfactory and full of promise for the future that this new enterprise should have reached a dividend-paying stage within 15 months of the commencement of its operations. On January 1, 1894, the station had only been at work for three months, so that the results of but one quarter of last year can be compared with those of the corresponding quarter of 1893. This comparison shows that for this period the current generated and the income derived from its sale had more than doubled. At the end of 1894 the Company had six engines and three boilers at work, compared with three engines and two boilers a year before. It has been found necessary also to erect a fourth boiler as a reserve in case of either of the others breaking down. A number of fresh customers have applied for current since January 1, and applications are still being made, so that the present machinery will not be sufficient to carry the station on through the next winter. The amount of current produced during the first 11 weeks of the present year shows the gratifying increase of 82 per cent. on the corresponding period of 1894, and it is not expected that the working expenses of the Company will increase in anything like the same proportion as the revenue. A year ago one place of worship had been lighted by electricity; now there are four, including the new Catholic cathedral. The advantages of the electric light are so decided, and the cost of it compares so favourably with that of gas, that the directors believe a considerable income will be eventually gained by lighting such buildings. At present the Company has nearly 4¾ miles of mains, compared with about 2¾ miles in 1893, but there are other streets than those already laid where a profitable demand for current may be expected. The machinery continues to work satisfactorily, and it gives results which will compare favourably with those of other electric stations. Much credit is due to the engineer and the staff for the efficient manner in which the business of the Company has been carried out during the past year. The result of last year's trading, after paying station and office expenses, and interest due to the bank, shows a net profit of £1,356. 11s. 4d., to which must be added £237. 9s. 10d., the balance brought forward from last year, making a total of £1,594. 1s. 2d. standing to the credit of the profit and loss account. Out of this the directors proposed to wipe off the preliminary expenses (£382. 4s. 2d.), and to place a sum of £400 to a reserve fund for machinery renewals, leaving £811 17s. available for a dividend. The directors propose to pay a dividend for the year 1894 of 3 per cent, free of income tax, and to carry forward the balance of £112. 5s. 8d. The directors have thought it better not to ask the public for fresh capital until they could show that the Company was likely to be a success, as to which, however, they had from the first little doubt, preferring to obtain the money they required in the form of a temporary loan from their bankers, but the time has now come to invite applications from the shareholders and the public either for further ordinary shares or for 4 per cent. mortgage debentures, a limited number of which they propose to issue. The directors who retire by rotation this year are the chairman and Mr. Buxton, and they offer themselves for re-election. Mr. Mottram, the audior, retires, but is eligible for re-election.

The chair was occupied by Mr. F. W. Harmer.

The **Chairman**, in moving the adoption of the report, said that though the work of the Company had given the directors a good deal of anxiety during the last three or four years, they had, happily, little cause for anxiety now. The Company had given great satisfaction to its patrons, not a single customer who had once adopted their service having given it up. They were under a great debt of obligation to Messrs. Laurence and Scott, whose plans in the main the Company had adopted.

Mr G F. Buxton seconded the motion, and the report was adopted.

The two retiring directors were re elected.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY.

The annual general meeting of this Company was held on Monday at the Cannon-street Hotel, Mr. William Addison in the chair.

The **Chairman** moved the adoption of the report, which was published in our last issue, and stated that the business of the Company was generally making progress. The subsidiary company in India called for little comment. The revenues were improving, and if silver rose in value they might expect better remittances from them. He hoped the China and Japan Company would also improve now that the war was ended. Altogether, the shareholders might congratulate themselves on possessing a business which was thoroughly sound. The report was adopted.

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INDO-EUROPEAN TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Monday at Winchester House, Mr. J. Herbert Tritton presiding.

In moving the adoption of the report, the **Chairman** said the year showed a slight falling off as compared with 1893. The fluctuation in the message business had occurred mainly in the trade with India, and would have been greater but that it had been partially compensated for by increases under other heads. With Indian business there could not be a continually-increasing amount of traffic, such as almost invariably made itself manifest with certain other communities such as Australia. The Governments of Australasia had extended their guarantee for the loss arising from the introduction of lower tariffs for another five years. The report was adopted.

MIX AND GENEST, LIMITED, BERLIN.

A meeting of the shareholders of this Company was held last week, at which a dividend of 11 per cent. payable forthwith was declared for the year ending December 31, 1894. The gross profit amounted to 434,552 marks, which, after deducting expenses amounting to 152,391, leaves an available profit of 282,161. After writing off 48,000 on plant and tools account and 40,000 marks off patent account, which latter stands now nominally at 1s. only, and after transferring 7,000 marks to the workmen's benevolent association, a balance of 690 marks was carried forward to the new account. The board of directors state that the works have been busy since the beginning of the present year with large orders from various Governments as well as from their regular trade customers, and the prospects are very promising, as all their hands, numbering nearly 1,000, are fully employed. The Company have concentrated their various works since the beginning of January in their newly-erected large factory, the cost of which, including outfit, came to 1,100,000 marks. The building, one of the finest in the telephone trade, is fitted up with the most modern machinery and appliances, and sufficient adjoining land has been acquired for an ultimate extension when necessary.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Birkenhead.—The Corporation invite tenders by 23rd inst. for boilers, engines, dynamos, etc. Particulars are given in our advertisement columns.

Tunbridge Wells.—Tenders are invited by the Corporation for the wiring of the Municipal Buildings in accordance with the specification prepared by the electrical engineer. Copies of the specification may be obtained from Mr. W. C. Cripps, town clerk, Town Hall, Tunbridge Wells, on payment of a deposit of £1, which sum will be returned on receipt of a bona fide tender. The buildings can be inspected at any time. Tenders, endorsed "Electric Light," must be sent to the town clerk by 28th inst.

Brighton.—Notice is given that the Council of the borough will receive tenders from such persons as may be willing to enter into a contract for the supply and erection of boilers at the Corporation electricity works. The Council also want tenders for the supply and erection of arc lamps, switches, etc., and, thirdly, for the supply of indiarubber lead-covered armoured cables. Specifications can be obtained on application at the town clerk's office, Town Hall, Brighton. Tenders for the boilers are to be sent in by May 13; for the arc lamps, switches, etc, by May 27; and for the indiarubber lead-covered armoured cables by May 13.

Rangoon.—Tenders will be received by the president of the Rangoon Municipal Committee, not later than November 4, for the lighting of Rangoon by electricity. Tenders should be accompanied by detailed plans, specifications, and estimates, and must state the terms on which the installation proposed will be undertaken. All information regarding the existing system of lighting and the cost, etc., with plan of the town, can be obtained on application to Messrs. Ogilvy, Gillanders, and Co., Sun-court, 67, Cornhill, London, E.C., accompanied by a remittance of £1. 1s. Tenders are to be sent in sealed covers and endorsed "Tender for Electric Lighting, Rangoon." Mr. J. Short, Rangoon, is the secretary of the committee.

Manchester.—The Corporation invite tenders for the supply, delivery, and erection, complete, of the electric lighting machinery and installation for the efficient lighting of the new foreign animals wharf, situated at Mode Wheel. Copies of general conditions, specification, and drawing can be obtained on application to Mr. T. de Courcy Meade, city surveyor, Town Hall, Manchester, on payment of five guineas (which will be returned on receipt of a *bonâ fide* tender). Tenders, to be endorsed "Tender for Electric Lighting, etc., Foreign Animals Wharf, Mode Wheel," to be addressed to the chairman of the Markets Committee, and delivered at the city surveyor's office not later than 9 a.m. on Monday, May 13. The Corporation do not bind themselves to accept the lowest or any tender.

Shoreditch.—The Vestry invite tenders for the erection of a dust destructor, 12 furnaces, flues, boilers, and accessories, to be guaranteed capable of dealing with about 20,000 tons of refuse per annum and of producing the amount of steam stated in the specification for electric lighting and other purposes. A formal contract to be entered into under seal, with sufficient sureties, to secure such guarantee. Forms of specification and sketch plan, with further information, may be obtained from Messrs. Kincaid, Waller, and Manville, the engineers, of 29, Great George-street, Westminster, S.W., on payment of £3. 3s., which will be returned to persons tendering on a bona fide tender being received by the Vestry. Sealed tenders must be sent to the vestry clerk, endorsed "Tender for Dust Destructor, etc.," by Monday, May 20, or by such extended period as may be specially allowed to any intending contractors upon application to the engineers; and contractors, or their representatives, must attend at the Town Hall, Old-street, E.C., at 6 p.m. on the same date, when the tenders will be considered by the committee. Trade union rates of wages and hours must be observed by contractors.

BUSINESS NOTES.

Western and Brasilian Telegraph Company.—For the past week the receipts were £3,130.

Sunderland.—The Corporation have now 29 customers for the electric light, and the number is stated by Alderman Bell to be increasing daily.

Rickmansworth.—Mr. Dockree has given a notice of motion at the next meeting of the Parish Council in favour of the introduction of the electric light into Rickmansworth.

Buxton.—The Urban District Council, it appears, intend to do nothing in connection with the electric light at present, but will apply for an extension of time when the powers expire.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 28th ult. amounted to £1,121, as compared with £667 in the corresponding week of last year.

Newcastle-on-Tyne.—A new branch of manufacture has been started at the Elswick Works of Sir W. G. Armstrong, Mitchell, and Co. in the production of the Thomson-Houston dynamos.

Electro-Hygienic Company, Limited.—This Company has been registered, with a capital of £20,000, to enter into an agreement with H. C. Braun and H. C. B. Sharman, for the acquisition of certain patents, patent rights, etc., particulars of which do not transpire.

Jandus Arc Lamp and Electric Company, Limited.—This Company has been registered, with a capital of £20,000 in £10 shares, to acquire letters patent relating to improvements in electric arc lamps, and to carry on the business of an electric company in all its branches.

St. Helens.—The Gas Committee of the St. Helens Corporation have approved of plans for putting down plant at the gasworks capable of lighting the Town Hall and the Gamble Institute by electricity, and also for meeting any further immediate demands for extension of electric supply in the neighbourhood.

Cardiff.—A De Laval combined steam turbine and dynamo of 5 h.p. has been installed on the premises of the *Western Mail* by Messrs. George Thomas and Co., of Manchester, who have lent the plant for experimental purposes, Mr. W. H. Massey having introduced the machine to the notice of the owners of the journal.

City and South London Railway.—The receipts of the Company for the week ended April 28 were £900, against £901 for the corresponding week of 1894, or a decrease of £1. The total receipts for the current period of the present half-year are £16,119 against £15,514 in the corresponding period of 1894, an increase of £605.

Lamp Manufacturing Company, Limited.—This Company has been registered, with a capital of £20,000, to enter into an agreement with the Lamp Manufacturing Company, Limited, and the liquidator thereof, and to carry on business as manufacturers of and dealers in lamps of every description, as electrical engineers, etc.

Business Change.—Mr. S. Crichton Hannah, of 5, John-street, Adelphi, W.C., who has been for over 20 years designer for Messrs. B. Verity and Sons, having severed his connection with the firm, informs us that he is now in a position to supply designs and working drawings of all styles of electric fittings, ironwork, etc., to the trade.

Islington.—A meeting of the Vestry has been held, at which the Vestry Clerk read a communication from the Vestry of Southwark, enclosing copy of a resolution passed by that body, suggesting the advisability of some authority having control over gas-mains, and having the power to compel the gas companies to repair them so as to prevent escape.

Metropolitan Asylums Board.—Sir Edwin Galsworthy presided at a meeting of the Board at the County Hall on Saturday last. A letter was read from the Electrical Trades Union asking that a clause with regard to trades union working regulations might be inserted in all the managers' contracts for electrical work. This was referred to the Special Committee on Contracts.

Bournemouth.—The Lighting Committee of the Town Council have recommended that permission be not given to the placing of a lamp near the Lansdowne Baptist Church. A letter had been received from the Bournemouth Electric Supply Company, Limited, stating that there had been no change in the constitution of the company involving a transfer of the undertaking.

Hampstead.—The Lighting Committee of the Vestry have recommended that the Vestry of Islington should be informed that the Vestry agreed with the views expressed in their letter on the subject of escapes from gas-mains laid under the public streets, and that a similar representation to that of the Vestry of Islington should be

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made to the Board of Trade on the subject. The recommendation was adopted by the Vestry.

Earl's Court.—The giant wheel in the exhibition grounds at Earl's Court has been completed. At night the wheel will be lighted by electricity, the plant for which has been supplied by Messrs. J. G. Statter and Co. A double line of incandescent lamps will encircle the periphery of the wheel on either side, in addition to which the cars, promenade-rooms, etc., will be brilliantly lighted by electricity.

Manchester Suburban Electric Supply, Limited.—This Company has been registered, with a capital of £25,000, to take a transfer from the Collier-Marr Telephone and Electrical Manufacturing Company, Limited, of a provisional order granted to them by the Board of Trade, and to supply electricity for any purpose whatsoever within the urban sanitary district of Moss Side, and as electrical engineers generally.

Tilbury.—The Parish Council have received a letter from the secretary of the London and India Dock Joint Committee stating they were in a position to supply the parish with the electric current for lighting purposes if by so doing they would not be infringing the rights of any other lighting company. The Clerk said he had seen Mr. Borradaile, who said the gas company had a monopoly for gas only. The matter was left over to the Lighting Committee.

Epstein Accumulators.—In addition to the central-station batteries for the Kensington and Knightsbridge Electric Lighting Company, Limited, and the Preston Electric Supply Company, Limited, the Epstein Electric Accumulator Company, Limited, have just obtained the order for two new batteries of large capacity from the Notting Hill Electric Lighting Company, Limited, to be erected at their central station, Bulmer-place, Notting Hill-gate, W.

Electric Lighting Bills.—At a sitting on Monday of the Examiner for the House of Commons, 13 Electric Lighting Bills were found to have complied with the orders of the House applying to them at this stage. The Electric Lighting Bills are for the confirmation of orders made by the Board of Trade in respect of Worthing, Winchester, Motherwell, Stirling, Alderley Edge, Leigh, Llandudno, Luton, Radcliffe, Swindon New Town, Carlisle, Pontypool, and Walthamstow.

Birmingham.—Some hitch, it is stated, has occurred with reference to the contract of Messrs. D. and G. Graham, of Glasgow, for the supply of the electric lighting plant for the new technical school in Suffolk-street. A special meeting of the sub-committee which has the matter in hand has been held, when the subject was considered, and the hope expressed on the part of the contractors and the committee that nothing would arise to prevent the work being successfully carried out.

Draycott.—The Parish Council have held a meeting at which the question of publicly lighting the streets came on for discussion, Mr. Astle remarking that he had decided to place a 16-c.p. electric light on the Station-road and not charge for it, just to give the people a chance of seeing the effect. He had had an expert's opinion on the question of laying down the current from Wilne to Draycott, but the expert had given it as his opinion that it would entail too much expense, so that would have to be abandoned.

Oldham.—The Electric Lighting Committee have reported to the Town Council that Prof. Kennedy has estimated the additional cost of extending the electric light supply at £10,000 Alderman Smith said the original estimate was for £27,000, of which £25,550 had been expended. There had been so many applications for the electric light that the Corporation had not the power required for the work. It had become necessary to extend the cables to Werneth Park and along Huddersfield-road in an easterly direction.

Rothesay.—A special meeting of the Harbour Trust has been held, at which a minute was submitted recommending that the pier be lit with electric light at an estimated cost of over £1,000. It was stated that the steamboat owners would oppose the scheme unless the esplanade and other parts of the town were embraced in it. The intention is to erect a 30-h.p. turbine wheel, driven by water from Lochfad, to generate the electricity. It is calculated that the new lighting will cost annually £280. The committee having the matter in hand were asked to deal with some objections, and to report early.

Twickenham.—The District Council have held a meeting at which two tenders were received for the erection of seven fire-alarm street posts, and electric call wires to 15 firemen's houses and the police station. Messrs. Harrison and Cole's tender of overhead wires was £217. 11s., with a reduction of £25 if wall boxes were used instead of posts, or with underground wires £766. 5s. Mr. Stewart's tender was £298. 12s. 6d. for overhead wires, or £1 184. 12s. 6d. for underground wires. It was decided to have overhead wires, but the final selection *re* tender was referred to the Works Committee and the surveyor.

General Traction Company, Limited.—This Company has been registered, with a capital of £50.000, to adopt and carry into effect an agreement expressed to be made between the Electric and General Contract Corporation, Limited, of the one part and this Company of the other part, and to enter into or acquire and carry out contracts or concessions or other grants in any part of the world for constructing, purchasing, or working railways, tramways, telegraphs, telephones, electric and other lighting works, electric, hydraulic, or other works, and for the equipment of any such undertakings or works with electric or other plant, stock, or apparatus.

Maidstone.—A committee of the Urban District Council have reported that they received an offer from Mr. Thomas King, in which he proposed to form a local company to take a transfer of the provisional order obtained by the Council. Mr. King submitted a draft agreement and deed of transfer, which had been considered by the committee, and certain alterations and additions would be suggested to Mr. King. The committee will shortly present a further report to the Council embodying Mr. King's proposals and a recommendation from the committee. The report was adopted without comment on the motion of Alderman Ellis.

Aberdeen.—The Gas Committee of Aberdeen Town Council have held a meeting at which the Electric Lighting Sub-Committee reported with reference to the supply of current for electric motors. They recommended that the supply be given during the day at 4d. per unit, and this was agreed to by six votes to two. It was resolved to recommend that the Council continue to rent the shop in Union-buildings at present used as a gas-stove depôt, and which is to be reconstructed and enlarged. The rent will be £100, but the electric lighting department will pay £20 of this sum, and one of the windows will be devoted to the exhibition of electric motors in action.

Telephony in Warwickshire.—A meeting of the Warwickshire Standing Committee has been held, at which Alderman Stanton enquired how it was that only one police station was to be connected with the telephone. It was widely thought to be very desirable that there should be a complete telephonic system throughout the county for police stations. Councillor Vero said Mr. Fielding Johnson had had this matter in hand, but unfortunately he had not been able to get the telephone company to give such terms and facilities as they felt they were entitled to have. Under the circumstances, it was not thought wise to connect all the stations in the county.

Copper.—There is something rather puzzling about the statistics of copper, says the *Financial News*. During the past month the stocks in England and France and afloat have increased by 904 tons, and now amount to 54 239 tons; but, although consumption failed to keep up with the supplies in April, the price of Chili bars has risen £1. 12s 6d. per ton since March 31. It is true that at £40. 17s. 6d. a ton copper is not at an extravagant figure; but how little statistics can be relied on in estimating the course of prices appears from the fact that on May 31, when the visible supply was nearly 7,000 tons smaller than it is now, copper was only £38. 17s. 6d., or £2 a ton cheaper than it is to-day.

Coventry.—At the last meeting of the Town Council, Mr. Morton questioned the chairman of the Electric Light Committee as to a statement made in a pamphlet which the Corporation had issued, which declared that the electric light at 6d. per Board of Trade unit was equal to gas at 4s. per 1,000ft. He thought there must be some mistake, and people were holding back from ordering the light because they felt it was going to be more expensive than gas. He asked the chairman if he could guarantee the statement as to comparative cost. Alderman Hill replied that his authority was the electrical engineer to the Corporation. The general district rate has been mortgaged for £5,000 at 3¼ per cent. for electric light expenditure.

Planet Electrical Engineering Company.—Judgment has been given by Mr. Justice Stirling in the action Wallace and others against the above Company. Plaintiffs are holders of £2,500 debentures of the Company, issued in December, 1893, and as no interest had been paid the principal money became due in default, and the usual debenture-holders' action was brought. The Company in February last passed a resolution for winding up, and this motion for judgment in the action was brought on by consent. His Lordship made an order declaring the debenture-holders entitled to a charge on all the Company's property, directing the usual enquiry, and giving liberty to apply in chambers as to sale.

Huddersfield.—The Corporation accounts for the past year show the following results: the sum borrowed amounted to £44,000, and there is still £6,000 sanctioned, but not borrowed. The total expenditure was £46.041, being £2 041 in excess of the amount raised by loans. The cost for the year for the generation and distribution of current, including royalties, rents and taxes, and management expenses was £2,184, and the receipts £3,580, leaving a balance carried to net revenue account of £1,376, which account shows a deficiency at the end of the year of £2,065. The quantity of units produced was 265,146, making the cost per unit generated to be 1·98d. There were 156,169 units sold, the cost per unit sold being 3·16d.

Rotherham.—Messrs John Dewhurst and Son, electrical and mechanical engineers, of Sheffield, have just completed an electric light plant at the works of Messrs. Baines and Co., brassfounders, Rotherham. The installation consists of a 10-unit "Hallamshire" dynamo, which is driven by the works engine, and 112 16-c.p. incandescent lamps in the turning shops. The 16-c.p. lamps, of which there is one over each lathe, are fitted with raising and lowering gear, enabling the workmen to adjust the light to the best advantage for the work they are doing. Each lamp is fitted with a switch. The yard and outbuildings are efficiently lighted by lamps of 32, 50 and 100 c.p. The installation is working very smoothly, and the proprietors speak highly of it.

York.—A special meeting of the York City Council, held on Monday, received the report of a committee making, among others, recommendations for the adoption of the scheme of the Electric Construction Company, of Wolverhampton, and the acceptance of the tender for the plant and fittings for £10,865, subject to powers being granted for a loan for the execution of the works

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Mr. Creer, the city surveyor, had reported to the committee that the low-tension three-wire system would be best for York. Eventually the committee's report was referred back with a request that the total cost of the entire plant, buildings, and land be given, and also a report upon the various works visited, and asking them to request Prof. Kennedy definitely whether or not he agreed with the advice given to the Council by Mr. Creer.

Crompton Electric Supply Company of Australia.—In the action of Whiffen and others *v.* the Crompton Electric Supply Company of Australia, Limited, and others, Mr. Butcher asked on Friday for the appointment of the secretary of the Company as receiver and manager. There were three series of debentures issued. Plaintiffs were holders in all of them. The interest was in arrear, and this step was taken in order to protect the property and assets of the Company, the whole of which were in Australia. The secretary was resident in England, but plaintiffs were ready to undertake for his receipts. The application was granted, but the judge reserved for chambers the question of appointing a deputy-receiver resident in Australia, and giving him power to make any necessary advances for carrying on the undertaking.

Ealing.—The Urban District Council have held a meeting, at which a letter was read from Messrs. Bramwell and Harris accepting the terms on which the Council had appointed them as consulting engineers of the electric lighting works. A communication was read from Mr. Strickland with reference to an account for the consumption of current. He questioned whether the meter was accurate and whether the amount of current charged for had actually been used. An opinion was expressed that as the accuracy of the meter was doubted it should be tested, but that in order to guard against any frivolous complaints of incorrectness in meters or in the amount of current used, the Electric Lighting Committee should be requested to suggest a charge to be imposed in cases in which a testing of the meter on the complaint of the consumer had resulted in the meter being found correct. The matter was referred to the Electric Lighting Committee accordingly.

Theft.—Horace Richard Eve, 21, a clerk, was charged on Friday at the Mansion House before Sir G. Tyler with stealing £237. 10s. from the Brush Electrical Engineering Company, in Queen Victoria-street. The prisoner had been about six months in the company's employment, and on the day before Good Friday he was the last to leave the premises. In the Easter holidays some workmen were engaged to paint the offices. On the return of the staff on Easter Tuesday it was found that a cash-box had been opened, and £237. 10s. abstracted. Subsequently the prisoner disappeared, and a rumour that he had been murdered was circulated. He was, however, traced to Aberdeen by the police, and arrested. He now pleaded guilty, and it was stated that his defalcations were caused by betting, gambling, and dissipation. Only £20 was found on him when arrested. The police stated that he had been previously convicted. He was committed for trial.

Kingston (Surrey).—The Lighting and Market Committee of the Town Council have reported that they informed the Street Improvement Sub-Committee that they were prepared to arrange for electric fittings to the labouring-class dwellings in course of erection in Pheasant-lane, and suggested that the current should be charged for by way of a fixed sum to be paid with the rent, the difference to be accounted for quarterly. The balance-sheet of the committee showed a debit balance of £3. 13s. 4d. Their estimated expenditure for the half-year was £3,196. 9s., including £1,050. 10s. to the gas company for street and Canbury Gardens lighting, £686. 17s. 5d. repayment of principal and interest on electric lighting loans, £500 for fuel, and £620 salary and wages; £450 was estimated as the income from consumers of electric light, leaving £2,746 to be raised from the rate. This sum included the cost of the street arc lights. The committee recommended a rate of 5½d. in the £, which will produce £2,750. The minutes were approved.

Hull.—We mentioned in our last issue that an enquiry was to be held by Colonel Charles Henry Luard, R.E., in respect to the proposed borrowing by the Hull Corporation of £2,800 for electric lighting purposes. There were present at the enquiry Mr. G. Duncan (town clerk's department), Mr. A. E. White (borough engineer), Councillor J. Shaw, Mr. Gibbins (electrical engineer), Mr. Milner (borough treasurer), and Mr. Redfern (borough accountant). Mr. Gibbins explained that the amount of £2,800 was to meet the demand of the public—for electric light—on the plant. The electric station had been in successful operation for 18 months, and they now asked for the loan for the purpose of meeting the demand of the town for electricity. They could at present supply 14,000 8-c.p. lamps, and if the loan were granted it would increase the output to 21,000 8-c.p. Mr. Milner said that the working of the electric lighting station had been very successful since its inception in January, 1893 At the end of the last financial year they had a balance in hand of £996, after meeting the demand for the sinking fund and interest. Colonel Luard then visited the electric station.

Aberystwith.—The Public Lights Committee of the Town Council have recommended that the Council should enter into a temporary arrangement with the Bourne and Grant Electrical Company for the running of the electric light for the public lamps pending the testing of the same, and that the Council offer to pay for the same at a rate not exceeding the rate provided by the existing agreement, but in the event of the light not answering the required test that the amount payable be in proportion to the candle-power as certified on behalf of the Council at the rate of £20 per annum per lamp of 2,000 c.p., the arrangement to be without prejudice to the rights or position of the Council, and to be terminated forthwith upon the result of the testing being communicated to the company. The committee likewise recommended that the lighting of the public streets by gas should be discontinued where other lamps exist. Mr. Breech, the electrician of the company, attended the meeting, and was requested to call the attention of the company to the absolute necessity of their immediately laying their second cable, and of completing the arc light at the town clock without further delay. The recommendations were adopted.

"D.P." Accumulators.—Up to the present this accumulator has been exploited by Messrs. Drake and Gorham, who appointed Messrs. Johnson and Phillips sole manufacturers for the United Kingdom. It has now been decided to form a separate company, known as the "D.P." Battery Company, who will take over the whole of the battery business from May 1. The London branch of the company, to which all enquiries should be addressed, will be situated at 66, Victoria-street, Westminster, S.W., the works being at Old Charlton, as at present. The company will retain the services of Messrs. Drake and Gorham, who, it will be remembered, were formerly managing-engineer and works manager of the Electrical Power Storage Company, and were afterwards connected with the Elwell-Parker battery, so that they may be said to have had an exceptional experience in battery work. The works will be under the able management of Mr. Claude Johnson, of Messrs. Johnson and Phillips, and considerable additions to the existing large plant are meditated. It is hoped that this consolidation of interests, trading under an independent title, which is less likely to arouse any possible jealousy on the part of the trade, will materially increase the business, which has already assumed very large proportions.

Derby.—The Town Council on Wednesday passed a resolution directing application to be made to the Local Government Board for sanction to the borrowing of £5,000 for electric lighting purposes. This sum was granted at the meeting of the Council held on March 6 last, and of this sum £3,134 has now been expended. Tenders have been invited for three mild-steel boilers, and the tender of Mr. E. Danks, of Oldbury Boiler Works (£1,570), has been accepted. The Electric Lighting Committee have engaged the following additional staff, which they consider sufficient to enable them to work the station without outside assistance: three arc light trimmers, 30s., 24s. 6d., 24s. 6d. per week; vulcanised jointer, £2 per week; jointer's assistant, etc., 24s. 6d. per week; carpenter, 32s. per week; storekeeper, 24s. 6d. per week. The machinery, etc., at the station has been insured for £24,250. A sum of £400 has been retained out of the moneys due to Messrs. Siemens Bros. as a security for the efficiency of the arc lamps for 12 months. Messrs. Siemens Bros. have been relieved from their responsibility of reinstating the roads upon a deduction being made from the moneys due to them of £100. The borough surveyor will now complete the reinstatement of the roads.

Acton.—The District Council have held a meeting, at which Messrs. New and Mayne were reported to have written accepting the insertion of the suggested sliding scale in the agreement for the lease of the provisional order, and asking that as they had met the Board in this matter the fact might be remembered in connection with any small points which might arise. Mr. Buxton moved: "That the resolution passed at the Council meeting of March 19, empowering the Council to sell the provisional order for lighting the parish of Acton with electricity to Messrs. New and Mayne be rescinded." This was seconded by Mr. Poulton. Mr. Grant moved that the proposition of Mr. Buxton be amended by the substitution of the words "not carried out until the opinion of the parochial electors of Acton has been ascertained," for the word "rescinded." He added that the Council might afterwards decide how to ascertain the feelings of the ratepayers. Mr. Lewsey seconded this. After further discussion the amendment was carried unanimously, and Messrs. Buxton and Rome were asked to prepare a statement as to what was proposed to be done in the matter of the electric lighting of the district, with a view to its being submitted to the electors with a request that they would express their opinion for or against the proposal to sell the provisional order to a private company.

Tunbridge Wells.—Current is to be supplied to the public at Tunbridge Wells at a charge of 6d. per unit. Petitions are being received from various suburban and other centres asking that the original electric light scheme may be extended. The Electric Lighting Committee of the Town Council report that they are unable to grant any of these applications, as the Council have entered into contracts which will absorb the whole of the money for which they have obtained borrowing powers. The committee are of opinion that it is desirable to extend the electric lighting works wherever there is a prospect of current being taken by a sufficient number of consumers to make it remunerative. The total amount of Mr. Preece's original estimate was £25,000, of which £13,000 was the estimated cost of lighting the compulsory area. As, however, many ratepayers beyond the compulsory area are willing and anxious to use the light, the committee are of opinion that the time has arrived when the Council should place themselves in a position to undertake extensions. They therefore recommend the Council to borrow the balance of Mr. Preece's original estimate—£12,000; to instruct the town clerk to apply to the Local Government Board for sanction to the necessary loan; and to authorise the Mayor to affix the seal to all documents necessary for that purpose.

Plymouth.—The Western District Ratepayers' Association have held a meeting, at which Dr. Square said Plymouth was dreadfully behind in the matter of lighting, and it was anything but

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satisfactory to think that such little places as Okehampton, St. Austell, and Taunton had got the electric light, while the big metropolis of the West was without it. Corporations generally were giving their attention to this matter. It had been proved that the ratepayers financially were very much better off by having the electric light, and the Plymouth ratepayers ought to be the owners of the electric light, and be able to make money out of it. Wherever the electric light had been adopted for public purposes the gas companies had done better, so that they were not trying to injure the gas company. At present Plymouth paid £4,000 a year to the gas company. The gas was very cheap, but he rather fancied he had seen gas of a better quality. The method generally adopted by corporations was to get a financier to float a company for three years, and at the end of that time, if it were a success, the Corporation took it over. Plymouth ought not to be behind-hand in this matter, and he moved that an installation of the electric light be adopted. It was generally felt that the question was of sufficient importance for a whole meeting to be devoted to it, and the matter was referred to the committee for their consideration.

Dover.—The inauguration of the electric light at Dover may now be said to have been fairly accomplished. The works cover an area of 10,000ft., with a height of 30ft. to the eaves. The rooms comprise engine and machine room, 100ft. by 30ft.; boiler-room 100ft. by 42ft., giving ample space for seven sets of engines and seven boilers; testing-rooms, secretary's offices, Board-room, stores, and lavatory. Besides these there are underground passages in which the circulating water-pipes and exhaust-pipes are placed running from the works to the river, about 100 yards distant. At present the plant includes two Babcock and Wilcox boilers of 200 h.p. each, working to a pressure of 150lb. each. In the boiler-room there is space for half-a-dozen boilers altogether. There will ultimately be four 100-kilowatt machines, one 75 and one 50 kilowatt machine. The work is estimated to cost about £40,000. and it is stated that there is room to extend the works to twice their size if required. Half the 21 public lamps at present supplied with the current are kept going from sunset to sunrise—six on the sea-front and four between there and the Market-square—and the remaining half are supplied from sunset till midnight. For this the Corporation pay the Dover company the sum of £650 annually, payable quarterly. For additional arc lamps erected the Corporation will have to pay £23 per annum for those supplied from sunset to midnight, and £30 for those supplied from sunset to sunrise. The price of current is 8d. per Board of Trade unit, with a minimum charge of 13s. 4d. per quarter.

Smoke Consumption.—In the Court of Bankruptcy the affairs of Mr. Samuel Elliott have been before Mr. Registrar Hope. The bankrupt, in reply to the official receiver, stated that he was a manufacturer of joinery and mouldings, carrying on business at the Albert Works, Newbury, and also having offices in the City. He started originally as a builder and contractor about 38 years ago, but the building trade became so bad that he was advised to change his business and go into the moulding trade. That was about six years since. The building business had not been a success, but the moulding and joinery business had been fairly successful. In 1889 he began developing patents. He invented a smoke washer, and exploited the patent on his own account. As a smoke washer the patent was eminently successful, but it was not a success financially. He had borrowed money in order to develop the patent, and had lost or sunk about £40,000 in connection with it. The bulk of his liabilities were in respect of the smoke patent, and his accounts showed liabilities expected to rank about £65,000, and assets £8,200. He had been in financial difficulties for some years, and he considered that about 500 executions had been levied on his property during the last five years, involving the payment of costs to the amount of something like £1,000 a year. For 10 years his banking account had been overdrawn, and since he had started the smoke patents his financial position had become more and more embarrassed. He had entered into a contract for the sale of the patents for £200,000, subject to a company being floated. The official receiver remarked that the company had all ended in smoke. The bankrupt admitted it, and said that he had charged the smoke patents for about £47,000. The patents were entirely a speculation outside his business and had caused his failure. Mr. Street appeared for the trustee, and Mr. Rolland for the bankrupt. Further accounts being required, the examination was adjourned to May 23.

Sandylands.—An adjourned annual meeting of the Sandylands ratepayers has been held for the purpose of considering the lighting question. Mr. J. J. Arnold presided. The notice convening the meeting having been read, the Chairman called upon the secretary to state what had been done by the inspectors and committee with respect to the law case against the Morecambe Electric Light and Power Company. The Secretary explained that the inspectors and committee had met the chairman and secretary of the electric light company, and an agreement was drawn up to the effect that the action should be withdrawn, each party paying their own costs, and that the inspectors have a right to use the lamps and lamp-posts free of charge until defendants are in a position to supply the electric light according to agreement; all cables, etc., to remain; also the original agreement for three years' lighting on the same terms, to commence after three months' notice has been given by the company. The Chairman said the inspectors required £50, in addition to the £50 voted at the last meeting, for lighting purposes. The expenses up to the present amounted to about £25, which included about £20 for solicitors' expenses with the electric light company. The average cost of supplying the 15 lights amounted to about £30 per year, and therefore an additional sum was required. Mr. Bottomley, replying to a ratepayer, said that so long as the electric light company was in operation the contract would exist. As soon as the new station was finished it would be to their advantage to light up the district. The company had already spent nearly £300 on the Sandylands contract. In answer to Mr. King, the Chairman replied that the plant already laid down belonged to the lighting authority until the company were ready to lay down electricity. Mr. Lambert said it was at the ratepayers' discretion as to whether the district was lighted with oil, gas, or electricity. Mr. King moved that the front be left as it is at the present until the latter part of the year, and this was carried.

Worcester.—The Town Council have held a meeting, at which the report of the Finance Committee was brought up, including the city budget for the ensuing year. The report was presented by Mr. Millington, who, in coming to the electricity department, said that many members of the Council had been anticipating that some estimate should be laid before them, and the committee had been consulted on the subject, but they thought that, as the business had been in existence for but a short time, it was unfair to ask them to give an estimate of the probable receipts and expenditure on the first year's existence. Mr. Millington offered an estimate, as his own statement, and for which the Electricity Committee were in no way responsible. For the information of the Council he might state that the revenue for the six months ending March 25 last amounted to £1,381. 19s. 7d., while the working expenses for the same period were £1,399. 0s. 5d., leaving a debit balance of £17. 0s. 10d., which did not include any provision for interest and repayment of capital. He would calculate interest on £50,000, although the Council had sanctioned £60,000. That made a sum of £2,996 for interest and redemption; salaries and wages, £1,100; coal, oil, repairs, tools, etc., £1,000. They had then to provide £5,096 in the 12 months. On the other side, what would be their possible receipts? They had 8,000 8-c.p. lamps, which at 8s. per annum would yield £3,200. By street-lighting £600, water pumping £450 (which item was, however, in dispute), and £200 by rent of mills. cottages, meters, etc. That made £4,450. It was only fair to ask what they would be doing in the next half-year? Supposing 2,000 more lamps were installed it would yield another £800, making the total receipts £5,250. Mr. Millington gave particulars of the capital expenditure on the electric lighting scheme up to April this year. Having regard to the question of which Mr. Rushton had given notice to ask as to the actual sum, out of the £60,000 voted by the Council for electricity works, spent up to the present time, Mr. Millington explained that actual payments and liabilities incurred, but not yet paid, amounted to £57,083. 6s. 1d. That left £2,916. 13s. 11d. out of the £60,000. In that he had not included the item of £1,068 claimed by the contractor as to the breaking of the water-dam, a claim in respect of which the Council did not admit their liability.

Hanley.—The Town Council held a meeting on Tuesday, when the Electric Lighting Sub-Committee submitted a report which, in accordance with the instructions of the Council, the borough engineer (Mr. Lobley) and the electrical engineer (Mr. Cottam) had drawn up for the further extension of the electricity works and mains. The extension scheme submitted includes provision for low-tension distributing mains for private supply of energy in the following streets: parts of Market-street, Bath-street, Hope-street, Etruria-road, Clough-street, Trinity-street, Piccadilly, Pall-mall, Stafford-street, Tontine-street, Charles-street, Birch-terrace, Jasper-street, Regent-road, Bethesda street, Broad-street, Snow-hill, and Stoke-road. To supply the above, high-tension mains are requisite in Market-street, Hope-street, Clough street, Bethesda-street, Cannon-street, George-street, Broad-street, Snow-hill, Stoke-road, and across the park by way of Wellesley-street, and Matlock-street. A second circuit of 30 arc lamps requires arc light cables to be laid in Hope-street, New Hall-street, Pall-mall, Albion-street, and Regent-road, also in Broad-street, Snow-hill, Stoke-road, Park-avenue, Victoria-road, Cleveland-road, and Outer Circle-road. The demand for current in the centre of the town necessitates the drawing in of a new high-tension cable of double the existing capacity between the works and the Town Hall, the existing cable being utilised in the other streets mentioned. The estimate for the above cables, including laying, is £5,508. The extensions of the mains require the provision of 16 sub-stations, 20 transformers, 25 junction-boxes of various kinds, and 30 arc lamps and posts. The estimates for these, including the extensions at the generating station, amount to £5,900. The street-lighting of the park roads, not provided for by arc lamps, includes 30 small lamps complete, and portions of the town where mains are being laid are provided for by fitting up 60 small lamps for electric lighting. These items, including the extension of the main switchboard arrangements, and a sum of £322 for excavation, formation of ground and railings at the generating station, are estimated to cost £1,242. In consequence of the increasing demand for electrical energy within the compulsory area, considerable extensions have been made to the machinery, mains, sub-stations, and transformers, amounting to £2,650; and the buildings, furniture, excavating, drainage, and formation of ground, amounting to £2,000. These items, together with a sum of £200 for clerk of works, printing, and stationery, not included in the original application, amount to £4,850. The first application on account of meters and stores, including fittings on consumers' premises for which rent is payable, was for £1,600. This sum has been exceeded by £250. A further sum of £1,250 is estimated to be required for the same purpose, which, added to the overdraft of £250, makes an estimate of £1,500. Total estimates for extensions £19,000, or including a sum of £1,000 for contingencies, special regard being given to the laying of mains to be provided to manufacturers to supply energy for

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motive power, £20,000. The following is given as a summary of the electric lighting scheme: first application, £21,000; second application for meters, etc., £1,000; third application for new steam alternator, £5 000; and present estimate, £20,000—making a total of £47 000. The committee recommended that application should be made to the Local Government Board for sanction to borrow the further £20,000 required, repayable in 25 years. The recommendations were thereupon adopted.

PROVISIONAL PATENTS, 1895.

April 22.

7966. **Portable electric apparatus.** Willard Elbridge Dow, 19, Southampton-buildings, Chancery-lane, London.

7989. **Improvements in electrically-driven wool-shearing or hair-clipping machines.** Harry William Charles Cox and Gershon Bowmar, 1, Queen Victoria-street, London.

7990. **Improvements in telegraphy and apparatus therefor.** Frederick Herbert William Higgins, 24, Southampton-buildings, Chancery-lane, London.

April 23.

8011. **Improvements in the electrodes or plates of electric storage batteries.** Georg Hübener, 70, Market-street, Manchester. (Complete specification.)

8026. **Improvements in electric railway systems.** James Michael Faulkner, 46, Lincoln's-inn-fields, London. (Complete specification.)

8037. **Improvements relating to electric telegraphs.** Alexander Muirhead, 124, Chancery-lane, London.

8049. **Improvements in or relating to electric alarm clocks.** William Phillips Thompson, 6, Lord street, Liverpool. (Henry Watson Knapp and Lawrence Edwin Gerrety, United States.) (Complete specification.)

8072. **Improvements in or relating to phonographs** Eduard Würl and Adolf Novotny, 323, High Holborn, London.

8081. **Improvements in the active material for secondary and primary batteries.** Alexander Schanschieff, 77, Chancery-lane, London.

April 24.

8135. **An improved electric light cask searcher and probe.** Frederic Hughes, 20, Paget-road, West Dulwich, London.

8139. **Improvements in lenses for search-light projectors.** Edward James Paterson and Claude William Hill, European Works, Pownall-road, Dalston, London.

8147. **Combined trolley and accumulator system for driving electric cars.** Theodor Nees, 323, High Holborn, London. (Complete specification.)

8161. **Improvements in electric igniting apparatus suitable for lighting tobacco-pipes and cigars.** Friedrich Wilhelm Schindler, 433, Strand, London.

April 25.

8167. **System of electro-calorigen rheostatic chain.** Armand Labre and Auguste Coussinet, jun., 77, Rue Denfert-Rocherau, Paris. (Complete specification.)

8172. **Belting for machine guns, dynamo, engine, and other purposes.** Richard Douglas Bailey, 34, Edith-grove, Fulham, London.

8186. **Improvements in electric locks.** Alfred Harvey, 128, Colmore-row, Birmingham. (Samuel Bash, South America.)

8188. **Improvements in ceiling roses and lampholders for electric lighting.** John Arthur Hirst, 8, Quality-court, Chancery-lane, London.

8195. **Improvements in cycle, electric, house, table, and other bells and gongs.** Orlando Hanks, 65, Mildmay-park, Islington, London.

8210. **A method of and means for increasing the directive force of magnetic needles.** John Sacheverell Gisborne, 19, Southampton-buildings, Chancery-lane, London.

8222. **Improvements in telephonic systems and apparatus.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

8226. **Improvements in and relating to electric batteries.** Johannes von der Poppenburg, 97, Newgate-street, London. (Complete specification.)

April 26.

8253. **Electrical appliance to give signalmen control over drivers during foggy weather.** Thomas Cooper, 29, Mount-pleasant, Rycroft, Walsall.

8306. **Improvements in or connected with electric batteries.** Charles Percy Shrewsbury, Frank Laurence Marshall, John Cooper, and John Laskey Dobell, 57, Chancery-lane, London.

April 27.

8373. **Improvements in conductors for coupling cells of voltaic batteries.** William Stepney Rawson, 28, Southampton-buildings, Chancery-lane, London.

8385. **An improved wire gauze brush for dynamos and motors.** Arthur Burgess Soar and Edwin William Collier, 8, Phipp-street, London.

8392. **An improved system of lighting and heating railway vehicles by electricity.** Morris Moskowits, Leon Daniel Adler, Abraham Sanford Adler, and Theodore Walter Myers, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8393. **Improvements in and relating to the electric lighting of railway vehicles.** Morris Moskowitz, Leon Daniel Adler, Abraham Sanford Adler, and Theodore Walter Myers, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8394. **Improvements in means for equalising the electromotive force of dynamos.** Morris Moskowitz, Leon Daniel Adler, Abraham Sanford Adler, and Theodore Walter Myers, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1893.

12662. **Electrolysis.** Andreoli. (Second edition.)

1894.

6323. **Alternating-current indicating apparatus.** Mordey.

6661. **Electric switches.** Rorke.

6850. **Electric lamp protector.** Ungley.

7176. **Telephonic systems.** Carbonnelle.

7477. **Vulcanising electric conductors.** Edmunds.

10132. **Electrical instruments.** Edmondson.

10425. **Electrical transformers.** Kingdon.

15414. **Telephone systems.** Warrell.

22986. **Primary batteries.** Hubbell.

1895.

2031. **Coupling for electromotors.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

3085. **Electric gas-lighting devices.** Jahnsson.

4045. **Incandescent lamps.** Friedländer.

4160. **Electric transformers.** Lake. (Thomson Electric Welding Company.)

4245. **Galvanic batteries.** Laura.

4458. **Electrically steering ships.** Langen.

4557. **Electric railway.** Pressley.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5⅜
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅝-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2½
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	15-15½
—— 5 per cent. Debenture Stock	115	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	128-131
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	—
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1⅛-1¼
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1¼
Elmore's French Company	2	—
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	9½-10½
—— Preference	—	12
House-to-House Company, Ordinary	5	3⅝-4
—— 7 per cent. Preference	5	7⅛-7¼
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅜-7⅝
—— Pref.	—	—
Liverpool Overhead Railway	10	8½-8⅝
—— Pref.	10	14-14½
—— 4 per cent. Mortgage Debentures of £100	100	110 112
London Electric	5	4-4⅛
Metropolitan Electric Supply	10	10-10½ xd
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	7⅛-7⅜
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref	5	5⅜-6
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7½-7¾
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7⅛
—— £4½ shares	4½	5⅞-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅛-8
—— 7 per cent. Pref.	5	8½-8⅝
Swan United	—	—
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7½-8
Yorkshire House-to-House	5	5¼-5⅜

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NOTES.

Wiring-In.—In connection with the Chitral expedition it is reported that the tribesmen in the Kutino district have been carrying off the telegraph wires.

Northern Society of Electrical Engineers.—Mr. J. C. Howell will read a paper before this society on Monday next on "The Uses of Accumulators."

Institution of Electrical Engineers.—A students' meeting will be held in the library of the Institution on Friday next, 17th inst., when a paper will be read on "Aluminium," by Mr. Gerald C. Allingham.

The China-Burmese Telegraph.—The new telegraph line in Upper Burma is now open right through to Pekin and Hong-Kong. India has thus secured direct communication with China *vid* Bhamo and Momein (Teng Yuah).

New Use for an Electric Railway. — Tommy Burns, the diver, has been using the Liverpool Electric Railway for the purpose of climbing on to the roof of a moving carriage and diving therefrom into a dock—a drop of 100ft.

The New Telegraph Line in the Shan Country.—The survey for the telegraph line from the Southern Shan country to the borders of the buffer State on the Mekong river has been completed. The wire can be put up without much difficulty.

Russian Electricians in England.—A party of Russian engineers, accompanied by M. Alphonse de Stchawinski, editor of the *Gazeta Elektrika*, St. Petersburg, have visited Brighton and inspected the works of the Rottingdean Electric Railway.

Telegraphy by Induction.—An address on this subject is to be delivered by Mr. W. H. Preece to a special meeting of the London Chamber of Commerce, which will be held in the hall of the Carpenters' Company, London-wall, on Thursday, the 23rd inst., at 2.30 p.m.

Application of the Electric Arc.—The discussion on Mr. Henry Foster's paper on "The Application of the Electric Arc to Machinery, Boiler Repairs, etc.," will be concluded at the meeting of the North-East Coast Institution of Engineers and Shipbuilders to be held at Newcastle-on-Tyne on Tuesday, the 14th inst.

Cantor Lectures.—Mr. James Douglas will on Monday evening next deliver the fourth lecture of his series on "Recent American Methods and Appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver," the subject being "Absorption of the Precious Metals to, and their Separation from, Copper and Lead."

Trolley Car Accidents.—A cablegram from New York states that the Brooklyn grand jury have indicted the managers of the Brooklyn Heights Railway Company for the recent deaths caused by the trolley cars on their lines. Altogether 107 people have been killed and 450 injured by the trolley cars in Brooklyn since they first came into use.

Telephony.—A new and well-written series of articles, entitled "Practical Telephony," is now appearing in the columns of our penny contemporary, *Electricity*. The series is being written by Messrs. James Bell, A.I.E.E., and S. Wilson, and should interest a large number of readers, especially in view of the enquiry now being held by the Government.

Fluorescence of Solutions.—Mr. O. Knoblauch, in *Wiedemann's Annalen*, shows that there is a constant ratio between the intensity of the fluorescence and the existing light, even when the intensity of the latter is altered in the ratio of 1 to 6,400. The author proves experimentally and theoretically that the effect upon the various fluorescent bodies of varying the solvent is very different.

Electrically-Propelled Vehicles.—Mr. Naoroji has asked, in the House of Commons, whether the President of the Board of Trade proposed to take steps for allowing vehicles propelled by stored electricity or petroleum, if unobjectionable to the public, to be freely used in this country. Mr. Shaw Lefevre stated that he was about to introduce a Bill upon this subject which he hoped would meet the views of the hon. member.

Royal Institution.—At the general monthly meeting of the members of the Royal Institution on Monday, Sir James Crichton-Browne presiding, the following were elected members: Mr. Henry Irving, Mr. Henry Perigal, Mrs. Slingsby Tanner, Mr. Ernest H. Fry, Mr. Thomas Muir, Mr. Harold Smith, and Mr. W. S. Smith. The special thanks of the members were given to Mr. George Matthey for his donation of £50 to the fund for the promotion of experimental research at low temperature.

Royal Meteorological Society.—At the ordinary meeting of the society, to be held by permission of the council of the Surveyors' Institution at 12, Great George-street, Westminster, on Wednesday, the 15th instant, at 7.30 p.m., the following papers will be read: "The November Floods of 1894 in the Thames Valley," by Messrs. G. J. Symons, F.R.S., and G. Chatterton, M.A., M.I.C.E., and "Barometrical Changes preceding and accompanying the Heavy Rainfall of November, 1894," by Mr. F. J. Brodie, F.R.Met.Soc.

Papers.—The last meeting of the present session of the Liverpool section of the Society of Chemical Industry was held last week at University College, when Dr. Hurter read a paper on "The Efficiency of Electrolytic Apparatus."—A meeting of the Property Owners' Association has been held at Patricroft, Eccles, when a lecture on "Gas *v.* Electric Light" was delivered by Mr. William Broughton. He did not favour the local introduction of the electric light. The matter has now been taken up in the correspondence columns of the local paper by Mr. Geo. R. Peers, A.I.E.E., and others.

Unipolar Induction.—Mr. Ernst Lecher in *Wiedemann's Annalen* discusses the different aspects of the question whether, when a cylindrical magnet rotates about its axis, the lines of force due to it are stationary or rotate with the magnet. The former was Faraday's original view, the latter has been maintained by Tolver Preston and others. After showing that all the experiments hitherto quoted as decisive one way or the other may be equally well interpreted on either assumption, he describes some test experiments which show that the lines of force stand still while the magnet rotates.

The Gmunden Electric Tramway.—In Austria-Hungary there has not been much progress made in connection with electric traction, but a line at Gmünden, a health resort on the lake of Traun, which has been completed, is interesting. It is short, being only about a mile and a half in length, but the gradients are very heavy, being as great as 9½ per cent., while the line is constantly going round curves, the smallest radius being 40 metres. The electrical work was carried out by Messrs. Egger and Co., of Vienna, the whole line being completed in four months. It is a single track, with a turn-out about midway. The overhead conductor system is employed, the return being by the rails.

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Cable Schemes.—Mr. Sydney Buxton (Under-Secretary for the Colonies) stated, in the House of Commons on Monday, in answer to Sir George Baden-Powell, that her Majesty's Government had not received any request from or through the Government of Canada to call a conference of the colonies interested with a view to arranging the details of the laying and maintaining a cable across the Pacific Ocean between Canada and Australasia. Mr. Arnold Morley, in reply to Mr. Henniker Heaton, said that about four years ago a request was made that a telegraph cable should be laid to the island of Sark, but as the estimate of revenue fell far short of the estimate of expenditure, the Treasury did not see their way to sanction the extension.

A Cock-and-Bull Story.—The following item is appearing in the provincial newspapers: "An interesting exhibition of a new device designed to prevent collisions at sea was recently given by Mr. James P. O'Brien between the Battery and Station Island, off New York. About 50 capitalists and electricians witnessed the force from electro-magnetic coils stationed on the tug 'Wild Hawk' influence a new chemically-prepared compass, causing the latter to ring bells instantaneously. The compass was placed at St. George and influenced as far as six miles on the water. The tests were a complete success. A syndicate of wealthy shipping men ordered 20 outfits for ocean travel. If successful for six months, Mr. O'Brien is to receive £100,000 for the patents."

Light Railways in Ireland.—In answer to Mr. Strachey, in the House of Commons, Sir J. Hibbert has said: "The Acts of 1883, 1889, and 1893 authorise the Treasury to give assistance to light railways and tramways, not exceeding a total sum of £65,000 per annum. Of this sum £30,722 is hypothecated to payments for which the Treasury has made itself liable in aid of guaranteed dividends, and on this account a sum of £21,240 was paid during the year 1894-95. The balance of the annuity of £65,000 is equivalent, when capitalised at 3 per cent., to £1,142,600, and the whole of this sum has been allocated to the lines mentioned at page 72 of the Civil Service Estimates of this year and to preliminary expenses and contingencies. The sum of £101,211 was paid on this account in the year 1894-95."

The Belfast Telephone.—Mr. Provand has asked the Postmaster-General in the House of Commons on what date the telephone trunk line was opened from Belfast to different towns in England and Wales; how many messages which had been paid for had passed over the line since then; and if the amount of business done would pay a profit after providing interest on the capital outlay and meeting all the expenses. The Postmaster-General replied that this line was opened to Liverpool, Manchester, and a few other towns on March 1. On the assumption that the honourable member referred to conversations with Belfast alone, he had to say that 16 conversations had been paid for up to the 20th ult.; but, of course, there had been other messages on the same trunk line. It was too early to judge of the financial result until further time had elapsed and the line had been placed in communication with other lines which were now in course of construction by the Department, and with the trunk lines of the telephone company which would shortly be acquired by the Department.

The Korda Thermo-Chemical Cell.—At a recent meeting of the Paris Academy, M. Désiré Korda read a paper on a "thermo chemical carbon cell." The author finds that if barium peroxide is heated to redness in contact with a carbon plate, the oxide becomes reduced to baryta, and a difference of potential of about one volt is produced, the carbon plate being negative. A similar result was obtained with cupric oxide as soon as a layer of potassium carbonate was placed between the oxide and the carbon, the difference of potential in this case amounting to 1·1 volts. The experiments were in each case performed by connecting a plate of gas-retort carbon by means of a platinum wire to one terminal of a Richard voltmeter, and placing on the carbon a few centimetres of the salt. A platinum wire dipping in the salt served to complete the circuit. On heating the carbon to a dull red heat in a Bunsen flame, a violent effervescence takes place, carbon dioxide being evolved; and the voltmeter shows a deflection corresponding to about one volt. This deflection remains constant as long as any of the higher oxide is left.

Thermo-Electric Generator.—We have received an advance proof of an article by Mr. H. B. Cox, which is to appear in our New York namesake, on the Cox thermo-electric generator for the conversion of heat directly into electrical energy. He uses gas as his heating medium. In the case of one type, in which the average gas consumption is 2½ft. per hour, varying terminal outputs may be had. For instance, machines are produced giving ½ volt and 90 amperes, 1 volt and 45 amperes, 5 volts and 9 amperes, 2 volts and 22 amperes, and 11 volts and 4 amperes. Mr. Cox claims that he has shown that a direct converter can be built which is practicable, permanent, and which shows a marked economy. While the first object in his work was to construct a machine in which mechanical and electrical effects were eliminated, the necessity for economy in fuel expense was also recognised. In the experimental work on the apparatus it was discovered that it required a particular form or kind of heat. So remarkable was the difference in output found to be with various forms and kinds of fuel that the output electrically was increased 300 per cent. by simply using the proper heat, and this increase was made with an actual saving of fuel. It is stated that the machines can successfully and commercially convert heat energy in any desired output, and that they show, even in small apparatus, a marked economy.

An Electrical Scare at the Sorbonne.—A curious accident occurred at the recent inauguration of the electric light in the Paris Sorbonne by the firm Clémançon, who have installed in this historic edifice 2,500 incandescent and 40 arc lamps. The occasion was also that of the centenary of the foundation of the Ecole Normale, and a brilliant assembly had gathered to celebrate the double event. The affair happened, just after the departure of the President of the Republic, in the large room of the Academic Council. The circuits of the incandescent lamps consisted of two leads covered with yellow silk, and the lighted candles of the chandeliers fitted with the lamps set fire, it appears, to one of the conductors, causing a short-circuit, which brought the lamps to the red, and the insulating material of the cable to melt upon the heads of the dancers. Great was the consternation, especially of the ladies; and a brave fireman, who, with considerable presence of mind, raised himself upon the shoulders of a comrade and essayed with vigorous blows of his helmet to extinguish the "fire," only succeeded in creating further alarm by smashing some of the lamps; and the apprehensions of those present were only at length allayed by an assistant of the Clémançon firm, who had been hastily summoned, and who simply switched off the chandelier.

The Battle of Keely-Cranky.—Keely, the motor man, bobs up serenely from time to time in the same way as proverbially attributed to a bad shilling. Someone who believes in him—or professes to do so—writes to the *New York Sun* to say: "I have been identified with the work of Mr. Keely for over 17 years, and have visited him in his

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laboratory perhaps 50 times, and have seen the progress of his work up to this time. He has now completed his vibratory circuit of force, and will soon show the wonderful 250-h.p. commercial machine now completed, and which is now being set up in his shop. Mr. Keely claims that the all-important connection has been completed, with the result that he has gained command of an accumulation of costless force drawn from the atmosphere; or, as he expresses it, 'a sympathetic force of outreach, representing in the full receptive circuit an accumulation of polar sympathy of more than 23 tons a minute when under rotation to be distributed to the polar and dipolar circuits' of his machine. In a long article recently published, it was stated by eminent electricians 'that polar currents of great force have been discovered, if we know how to utilise them of value.' Mr. Keely made this same statement years ago, and was laughed at. He has now harnessed these polar currents for commercial use. These polar currents form the foundation, as it were, of his discoveries." We have all heard years ago the story that Keely is just about ready to show his machine, but he never seems to get any "forrader" save when some credulous person gets taken in and writes him up in a language which is not to be understanded of the people.

Personal.—A boating accident took place near Portrush the other day, three persons being drowned. Four others were rescued with much difficulty and at great peril by Mr. Traill, of the electric tramway company, and other residents of Portrush.—Mr. W. R. Brook, says the *Indian Engineer*, has made over charge of the Telegraph Department to his successor, Mr. Reynolds, and has sailed for England, thus closing a connection of over 37 years with India. Looking back to the Mutiny period, he can trace the slow development of the Indian telegraph system during the first 25 years of his service; then the quickening up all along the line as a more liberal policy was adopted and the "deferred" rate was introduced; and finally, during his own term of office, the rapid extension of the wire to every part of the country. The progress made since 1889 has indeed been remarkable, and the retiring Director-General has well earned the highest award of praise which a grateful Government can give. When he succeeded to his post there were less than 35,300 miles of line and 106,400 miles of wire: now the figures are 44,600 and 138,800 respectively. The number of departmental signalling offices has sprung from 880 to 1,350.—The City Commissioners of Sewers have appointed Mr. A. A. Voysey, their electrical inspector, electrician to the Corporation.—What the Scotch term "a short leet" has been selected by the Electric Lighting Committee of the Hampstead Vestry for the post of electrical engineer. The leet comprises the following six gentlemen, who were to be interviewed by the Vestry yesterday: Mr. G. Cottam (Hanley Corporation Station), Mr. G. B. Dunn (Metropolitan Electric Supply Company), Mr. H. D. Munro (Exeter Electric Light Company), Mr. E. Sayer (assistant, Hampstead Vestry Station), Mr. A. M. Sillar (Messrs. Statter and Co.), and Mr. J. E. Stewart (Derby Corporation).

Electricity and Lock-Gates.—The locks which have recently been completed on the ship canal at Ymuiden, near Amsterdam, are claimed to be the largest in the world. Their dimensions are: length, 200 metres; width, 25 metres; depth, 9·20 metres above low-water level. Each lock is furnished with six pairs of gates, which divide it, and permit the rapid passage of small vessels. Powerful capstans on each side of the canal assist the progress of the craft. Hand-power for working the gates and capstans was, of course, out of the question. It was necessary to choose between two systems—electricity and hydraulics. The latter, although the general method, had the disadvantage that considerable care had to be taken in winter to ensure the uninterrupted operation of the locks. Accordingly, in June, 1893, the Dutch Waterstaat Minister put the question in the form of a competition, the result of which is that Figée Bros., engineers, of Haarlem, and Schuckert and Co., of Nuremberg, authors of an electrical project, have been invited to make preliminary trials at the Ymuiden locks and lock-gates, with the view principally of determining the exact power necessary to operate the gates. For this purpose a temporary building will be constructed near the locks, and will contain the necessary machinery for producing the current, which will be transmitted by overhead wires to two capstans capable of developing a force of 1,000 kilogramme-metres per second. Strong chains or steel cables fixed on the capstans and fastened to the gates will serve to keep these with a difference of 10 centimetres between the level of the basin and the level of the canal. The definitive installation will comprise a powerful battery of accumulators, permitting in case of need the working of the gates without the aid of the dynamos. The results of the trials will be awaited with interest, but no doubt is entertained that in this case, as in so many others, electricity will offer considerable advantages over hydraulic power which has almost exclusively been employed up to the present in operating lock machinery.

The "Ingratitude" of Electrical Engineers.—We referred last week in a note to the chief subjects treated of in Prof. Unwin's "James Forrest" lecture at the Institution of Civil Engineers on the subject of "The Development of the Experimental Study of Heat Engines." A short digression was made by the lecturer, who said: "In popular writings nothing is commoner than to find the efficiency of electric machinery and of steam machinery contrasted to the great discredit of the latter. The dynamo, it is said, has an efficiency of 90 per cent. to 95 per cent., the steam-engine an efficiency of only 10 per cent. What a barbarous machine, after all the labour of a century, the steam-engine must be! The comparison is generally made by an electrical engineer, and the first reflection which occurs to one is that of all people the electrical engineer should be the last to abuse the steam-engine, for whatever may be the case in some future century, at present the dynamo is absolutely dependent on the steam-engine. Without the steam-engine the dynamo would be a useless mass of metal and wire. But passing over the moral aspect of the question—the ingratitude of the electrical engineer—the comparison is an unfair one, and shows a want of apprehension of the important law of the motivity of heat, which is one of the two fundamental laws of thermo-dynamics. Heat energy is undirected or mob energy. It lies in the nature of the terrestrial conditions in which use has to be made of it that only a fraction is convertible into directed or mechanical energy. The task of the steam-engine is to do its best with the fraction which is convertible, and in that point of view it is not an inefficient machine. The dynamo has a much easier task. Energy is supplied to it in its directed or wholly convertible form, and naturally in transforming one kind of directed energy into another kind of directed energy only a small fraction need be wasted." The supposedly ungrateful electrical engineer, however, deserves gratitude from the maker of steam-engines, whose trade has been improved by the orders received from the former.

Street Subways for Large Towns.—Mr. Charles Mason, A.M.I.C.E., surveyor to the Vestry of St. Martin-in-the-Fields, on Monday night read a paper on this

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subject before the Society of Engineers. In the course of the paper, he stated that the old-fashioned method of laying underground pipes was such that a periodical inspection of the mains for ascertaining their condition or for stopping leakages, was almost impossible. Especially was this the case with the gas and electric mains, and the recent explosions in several parts of the Metropolis had imposed a duty upon those having the control of the streets to devise some better system, whereby material of whatever nature laid under ground could be easily examined from time to time. The construction of subways was the most satisfactory, and, in fact, the only, method for laying pipes and mains, so that these conditions could be complied with. He went on to say that examinations for leakages were the main cause of disturbance in the pavements, these being generally made in a haphazard kind of way, as it was somewhat a matter of guess work to define the exact spot requiring attention. In a recent examination in the Strand near Charing Cross, an irregular area of about 19 square yards was displaced by an electric light company before discovering the leakage for which a search was being made. Had the exact spot been known, the whole could have been repaired with less than one yard superficial of the road having been disturbed. This one leakage cost at least £14 to discover, apart from the cost of the actual repairs to the electric conductor. Mr. Mason described a triple subway which he had designed, in which the electric light mains (among others) were carried by brackets built into the wall, while telegraph, telephone, and lighter wires were attached to the overhead arching. Should it be necessary and desirable to construct electric transformer-chambers for the high-tension cables, these could be placed in arched openings in the division walls of the subway, but in the author's opinion all transformers should be entirely upon the property of the company owning the same. Mr. Blair, surveyor to the St. Pancras Vestry, considered that there would be danger from gas explosions if the gas-mains were carried in such subways, but Mr. Mason replied that he did not think so.

Central Technical College.—We have received the programme of this college of the City and Guilds of London Institute. In the department of physics and electrical engineering, under Prof. W. E. Ayrton, the complete course of instruction which is given is specially designed to meet the requirements of persons who desire to obtain a technical knowledge of physics, either to enable them to rightly understand the processes carried on in certain industrial operations, or to fit them to become technical teachers. The special industry to which attention is mainly directed is that of electrical engineering. The instruction is given largely by tuition in the laboratory, the lectures being rather for the purpose of aiding the students in their laboratory practice than of forming a distinct course by themselves. The laboratory work is of two kinds; that for the first-year students consisting mainly of quantitative experiments arranged for the verification of the most important well-known laws, while that for the second-year students will, in addition, be directed to training them to carry out original investigations. In the third year the work done by the more advanced students will be of an original character. In addition to the lectures and laboratory work, classes are held for the working of exercises; the students are also taught to construct and repair physical apparatus in the physics workshop. During the session, courses of lectures and laboratory instruction are given on (1) practical physics; (2) electrical technology; (3) advanced electrical technology. The laboratory course on electrical technology is given in the three electrical and magnetic research laboratories (which are fitted with more sensitive measuring apparatus than that contained in the electrical and magnetic laboratories for first-year students), in the arc lamp room, the optical testroom, and in the dynamo and motor laboratories. The latter are furnished with direct-current dynamos of the series, shunt, compound-wound, and constant-current types, as well as with alternating and multiphase current machines. These dynamos are driven from coned shafting, by means of which the speed can be varied at will. The laboratories also contain electromotors, transmission and absorption dynamometers, a large number of accumulators, transformers, commercial meters, as well as delicate electrical measuring instruments that can be used near dynamos. This laboratory course, besides experiments on dynamos, motors, transformers, accumulators, condensers, arc and incandescent lamps, etc., embraces the measurement of the strength of magnetic fields, the magnetic properties of iron, coefficients of self and mutual induction, the calibration of various commercial electrical meters, and generally the carrying out of electrical work which is too technical or too difficult for first-year students.

Alternating-Current Motors.—Mr. Alex. Rothert has read a paper on "Motors for Single and Multiple Phase Alternating Currents" before the Elektrotechnische Gesellschaft at Frankfort-on-Main. After referring briefly to the long-cherished wishes with respect to the practical manufacture of alternate-current motors, he described the various existing types of these and the action of a continuous-current motor, and remarked that in synchronous running the armature at any instant always occupies the same position relative to the field, otherwise these motors are built the same as alternating-current dynamos. He mentioned three particularly great disadvantages of the synchronous motor: (1) it does not run alone; (2) when overloaded it remains at a standstill because the rotary effort, when it comes out of the phase, is first in one direction and then in the other; (3) for exciting the field system a continuous current is necessary. Owing to these drawbacks, the use of synchronous motors is limited. They are especially suitable in the case of long-distance transmission. For instance, this system is employed in Cassel, where the current is transmitted from a remote source of water power. In order to diminish this liability to fall out of step, the armature field must be made weak and the magnet field as strong as possible. The use of continuous-current motors for alternating currents is also very unimportant. They require large dimensions, show considerable phase-retardation, and sparking at the brushes is not to be avoided. The induction motors, in which external current is carried to the armature, are better. The Behn-Eschenburg motor has also the drawback of excessive sparking. The experiments of Ferraris in 1885-86, and also those of Tesla, have led to practical results. The use of multiple-phase motors began with the Frankfort Exhibition. A rotary field is produced by three alternating currents differing 120deg. in the phase, in a ring magnet furnished with a so-called star or triangular winding. The armature consists of laminated iron, and has a closed winding in which the induced currents are produced. The motor rotates in the direction of the rotary field, and runs almost synchronously. A constant speed and easy running are the special advantages of this type. Mr. Rothert illustrated the very high efficiency of rotary-current motors, and then described those with variable numbers of revolutions constructed by Siemens and Halske, which run asynchronous. In conclusion, after describing the single-phase motor of Brown and Oerlikon—which does not start of itself—he touched upon the different usages of the alter-

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nating and rotary current motors. Synchronous motors are adapted for long-distance power transmission; non-synchronous for medium powers, or where the motor has to run without attendance—for instance, in cranework. These motors can then be constructed without brushes and connecting rings. They all have the disadvantage that the speed cannot be regulated.

Machinery Users' Association.—The annual meeting of this association was held on Wednesday, Sir Wm. Houldsworth, Bart., M.P., in the chair. The total receipts for the year ended March 31 last, including balance brought forward, were £1,058, and the expenses £691, leaving a balance of £367 in hand. The committee reported that satisfactory progress had been made. They gave details of the parliamentary progress of the Bill for exempting tenants' machinery and tools from rating, which now only awaits third reading in the House of Commons, and this has been put down for June 19, when it will be the first order of the day. The committee congratulate the members of the association on the progress the Bill has made during the session, which is more than in any previous year. This success, however, has stirred its opponents to make increased efforts to obtain its rejection. A deputation from five northern assessment committees and property owners' associations met in London on March 26 last, when several members of Parliament made speeches against the Bill and an opposition campaign was inaugurated. The committee confidently rely on the tried support of those who recognise the importance of freeing the industries of the country (including agriculture) from all burdensome restrictions that tend to impair their development, to render futile this attempt to defeat a measure which the country has asked for many years past. Considerable interest was aroused by the action of Messrs. Sir Joseph Whitworth and Co., in the Chorlton-upon-Medlock Union, in raising the question of the rating of machinery by appeals against the assessment of other firms in the union, in comparison with which they considered themselves to be unfairly assessed. Several conferences took place between the association's advisers, who acted for the firms attacked by Messrs. Whitworth, and the appellants, but owing to various difficulties that arose, all the appeals were finally withdrawn, and the costs incurred were paid by Messrs. Whitworth. Certain important manufacturing centres have been considerably agitated during the past year by attempts to tax their machinery. In most cases, rather than defend their action in the law courts, the assessment committees have met manufacturers with considerable reductions. This shows the importance of having the rating of machinery placed on a satisfactory basis by Parliament. The statements made in last year's report as the system under which valuers canvass for employment attracted very considerable comment, and much indignation has been felt in industrial circles that the existence of such a system should be possible. The committee carefully considered and determined to oppose the London Valuation Bill introduced by the London County Council, which was withdrawn owing to the ruling of the Speaker that it could not be considered as a private Bill, and have also considered other matters affecting the interests of members in different localities. Questions of water supply and the disposal of manufacturers' effluent are now under consideration, and members will be fully advised of any action that it is deemed desirable to take.

Electrotherapy.—Dr. W. S. Hedley, of Brighton, who has previously dealt with the question of resuscitation from electrical shock, now contributes a long article to the *Lancet* under the title of "Apologia pro Electricitate Suâ." He states that those who have watched the solid, even brilliant, progress of electrotherapy in recent years acknowledge with regret, and not without surprise, that there is still a remnant of physicians who seriously doubt its capabilities, who refer to it as a "discredited agent," as something that has been tried and found wanting, or who, falling back upon a favourite phrase, express themselves as "disappointed in it." Of this remnant there is a certain minority even more aggressive in its attitude, more hostile in its scepticism. It is composed of those who roundly assert that neither does there exist any rational basis for the employment of electricity in medicine, nor is there any satisfactory demonstration of its curative effects; that once an agent of undoubted therapeutic promise, electricity now stands forth an admitted failure; that any good results that follow its use are due to psychical influence and rest on the baseless fabric of "suggestion." Dr. Hedley then proceeds to give a history of what has been done, and what is being done, and comes to the conclusion that, looked at from the standpoint of modern practice, the field of electro-therapeutics seems broadening. No longer limited to strictly local applications, it now embraces those procedures whose aim it is to influence, and which demonstrably can influence, the entire economy. Its object is so to utilise electro-physiological data as to influence innervation, heart action, muscular conditions, respiration, temperature, the oxidations, every functional action and metabolic change, and not least by the process darkly known as "vaso-motor influence" to modify and control the blood supply to organs and tissues. There are times when the power of electrisation to reach an internal organ will depend not on any direct action inherent in an electric current, but on an influence which, having its starting point in the electrical stimulation of some surface area, and travelling perhaps *vid* nerves of common sensation, will strike the spinal cord at some special spot, and reflected thence will find a route by filaments of the sympathetic to some particular organ, an organ thus in neural relationship, through this special segment of the cord, with that area of cutaneous surface which was the site of the electrical stimulation. France, America, and Germany are at present each the active centres of an onward movement in electro-therapeutics—a movement which experimental investigation, clinical observation, and organised association go hand-in-hand to accelerate and to strengthen. Another mark of progress appears in the fact that physiologists begin to recognise that chemical and electrical processes are inseparable from those that have hitherto been called vital, and that E.M.F. is very constantly the outcome of physiological action. There are signs that physics begins to "encroach on the domain of physiology, and that medical men are more and more turning their attention to physics." What has been called "physical biology" or "biological physics" seems already beginning to differentiate itself, and to stand out as a special branch of science. It forms a kind of neutral ground where medical and electrical science find a common holding point and a common end. To the medical man his line is clear. With the lessons of experience well in view he takes his stand upon the broad principles of electro-physics and the known action of electrical currents on vital structures. When such indications fail to guide him, and fail they often must, he will not on that account fold his arms in helpless inaction, but falling back upon an enlightened empiricism he will gently feel his way. He will "not ask, but try." He will not be afraid to acknowledge that after all is said therapeutics is to a large extent but a process of cautious experimentation.

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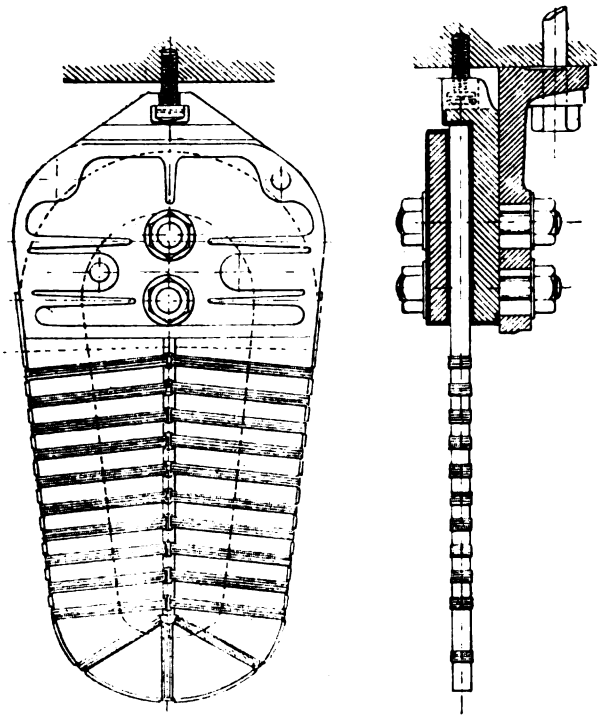
LEICESTER ELECTRICITY WORKS.

(Continued from page 502.)

The Alternators.

These machines are of the Mordey-Victoria type, of the same general design as those used in the Bankside station



FIGS. 11 AND 12.—Plan and Sectional Elevation of Mordey Alternator Coil.

of the City of London Electric Lighting Company. The armature is stationary, and in the 200-kilowatt set consists of 120 coils mounted on a gunmetal ring, which is bolted to a cast-iron frame divided into four sections. Two of these quadrants are below the floor level and two above. They are hinged about points near the horizontal centre line so that the upper quadrant can be swung back for inspection or repairs, while the lower segment can be let down into the cellars for a similar purpose. The coils can

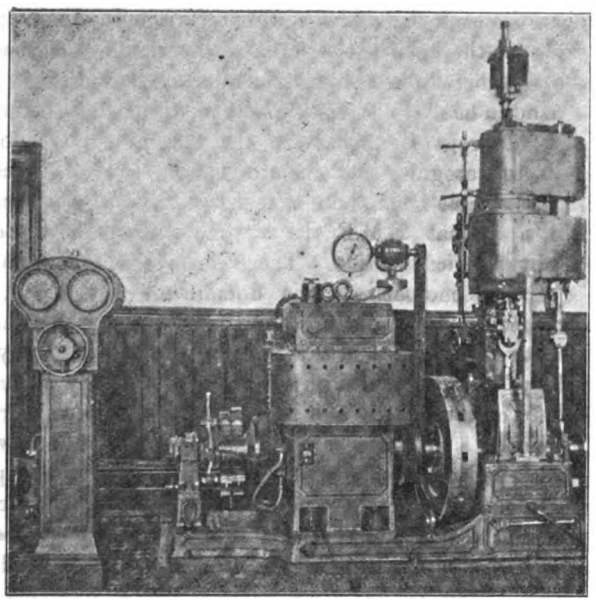


FIG. 13.—Exciter Plant, with Switch Pillar.

also be well examined *in situ* with the construction of field magnets used by the Brush Company. The two halves of the armature are connected in parallel, and an equaliser, to prevent wasteful currents circulating in the armature, is placed in one of the end girders. The field magnets consist of massive steel castings, with 60 pairs of polar projections, and excited by one large field coil placed in the centre between the claws of the magnet. The energy required for excitation with the large alternators is found to be 4,320 watts, which is 2·16 per cent. of the output.

Mr. W. M. Mordey has given long and careful attention to the perfection of the mechanical and electrical construction of the armature coils, which should conform to the following qualifications: (*a*) high insulation between coil and frame and between adjacent coils; (*b*) each coil to be mechanically strong and stiff enough to do its own share of work without mutual support from its neighbouring coils; (*c*) perfect interchangeability, so that any coil can

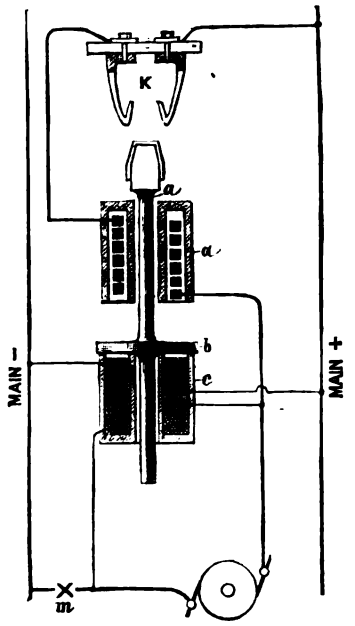


FIG. 16.—Connection in Exciter Pillar.

be fitted to any machine and immediately worked without any mechanical alternation *in situ*.

The result of his experience and successive improvements with the above aims in view is shown in Figs. 11 and 12. A radial adjustment is provided by which the

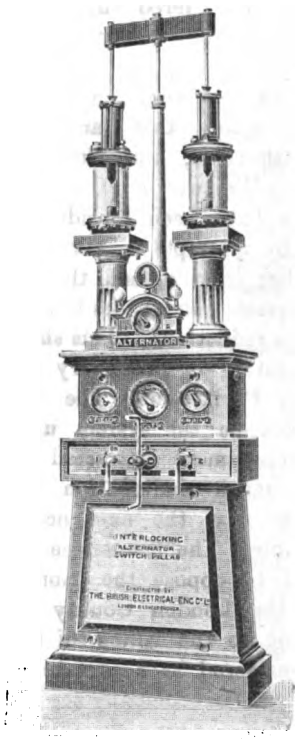


FIG. 17.—Alternator Pillar.

coils may be tightened down until they touch one another, but it is found that with these new coils mutual support is not necessary. The supports of the coil are of German silver, ebonised over all the necessary surfaces for purposes of insulation. The coil and its clamps are self-contained, and may be removed from the armature ring simply by slackening the two nuts shown at the back of the ring.

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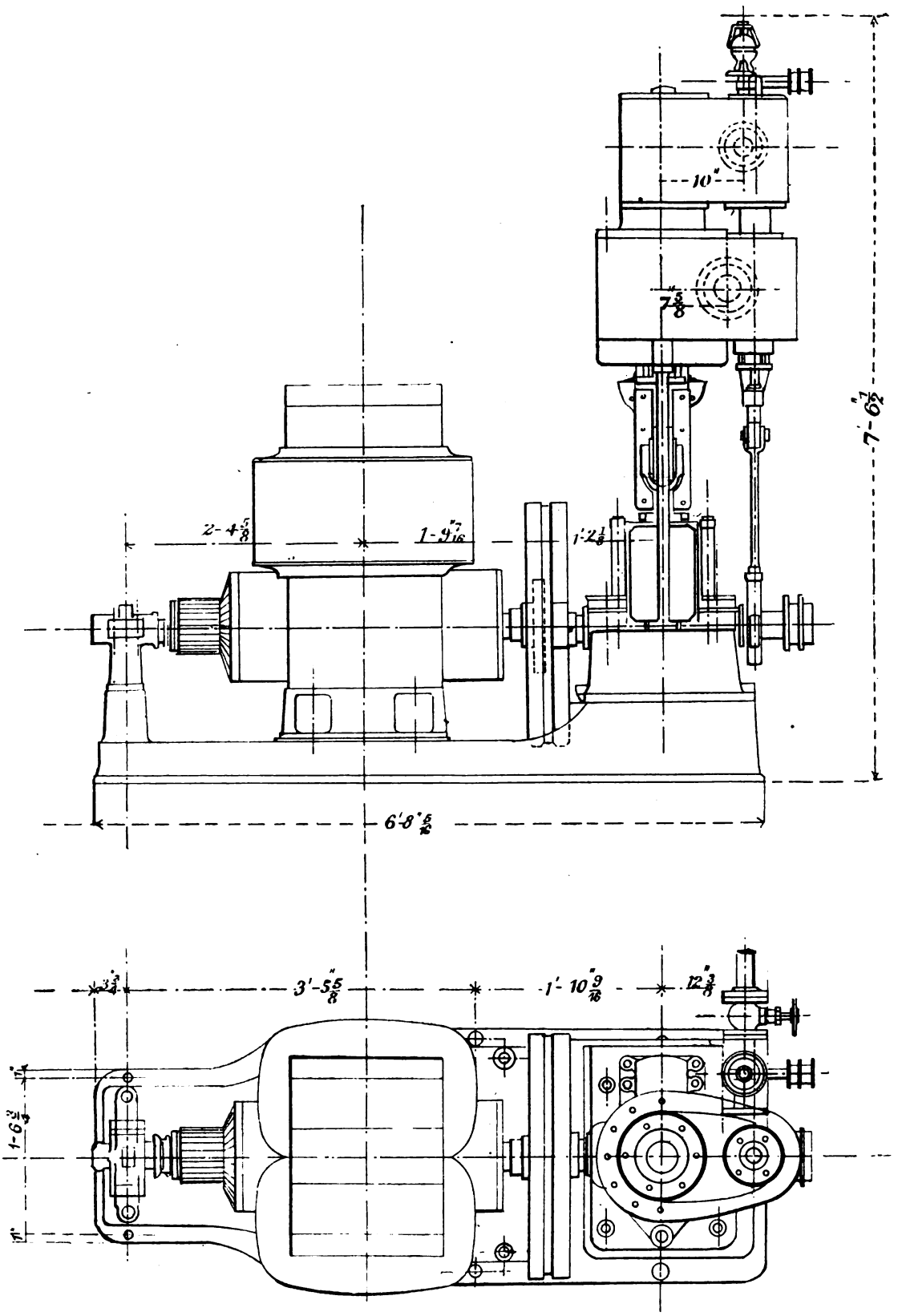
The core is of slate, and has a series of holes down the centre line. After the copper conductor has been wound on and a sheet of anti-sparking material placed over it, pressure is applied, and then the whole is bound tightly together by whipcord threaded through these holes in the core. In this way the slack usually taken up after running is removed before the coils leave the shops. The alternators at Leicester were not erected or tested at Loughborough, and since erecting in the station the armature coils have not given the slightest trouble, neither have they needed any subsequent adjustment.

The whole of the revolving parts are most carefully balanced, and run without oscillation. The bearings are made to swivel, and with this construction, combined with the Raworth coupling, assures that there can be no side thrust on the brasses.

Exciting Plant.

The exciters consist of two Brush-Falcon compound-wound direct-driven dynamos, Fig. 13, each having an output of 12,000 watts at 50 volts. Either is capable of exciting all the alternators at once. The engines, which are of Brush manufacture, have tandem compound cylinders 6in. and 10in. by 8in. stroke. Raworth's patent electric control governors are fitted to these engines, and by means of a resistance in the governor circuit the voltage of the supply from the whole of the station can be regulated from one place. Figs. 14 and 15 show the general dimen-



FIGS. 14 AND 15.—Plan and Elevation of 12-K.W. Brush Direct-Driven Plant.

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sions of these sets, but the electric control governors are not shown in these drawings, but can be seen in Fig. 13.

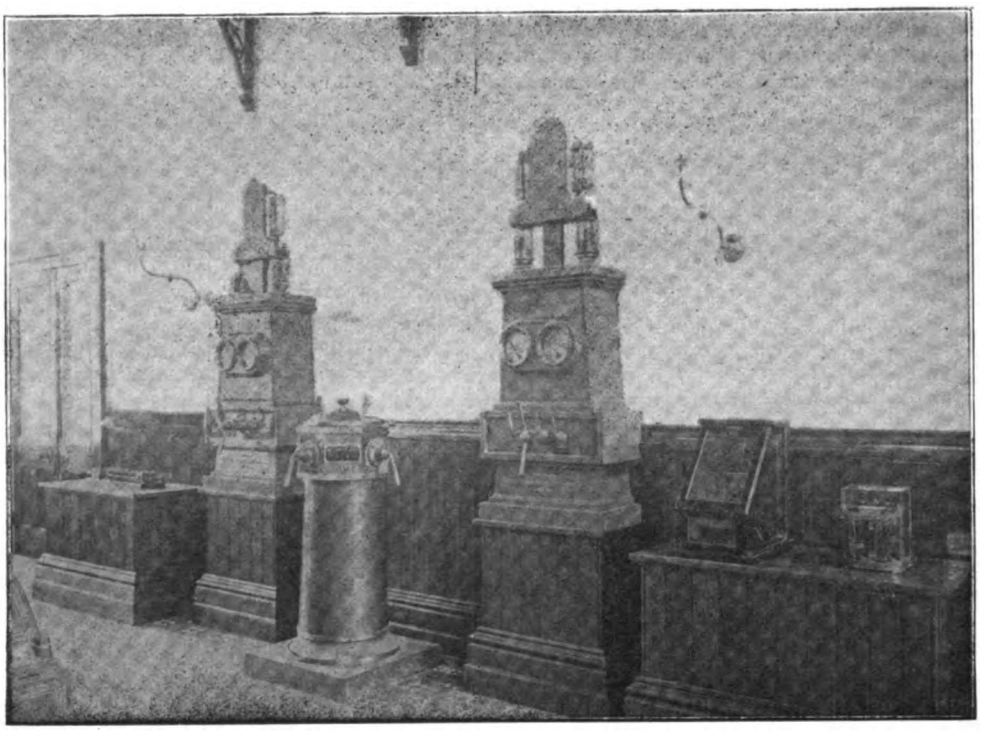
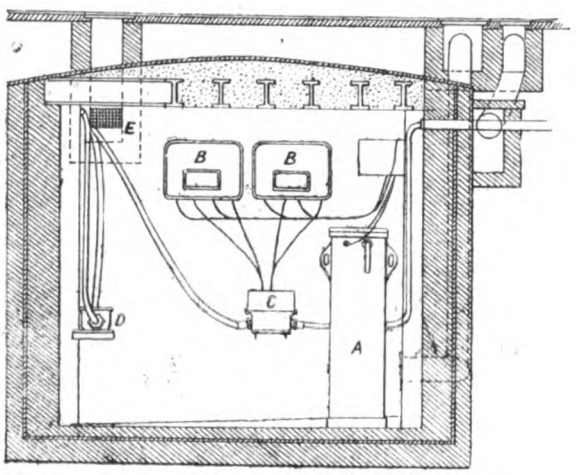
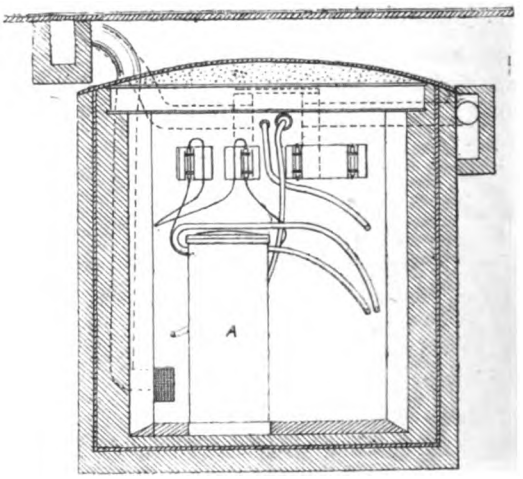


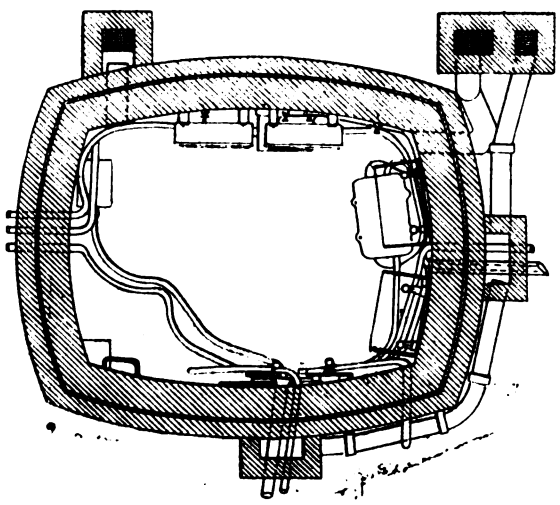
FIG. 18.—Dividing Table and Feeder Pillars.

Switch Gear.

The two exciters feed on to a pair of omnibus conductors, which supply the field magnets of the alternators in parallel. Opposite each exciter stands a cast-iron switch-pillar, containing a switch, Fig. 16, which automatically closes the circuit when the E.M.F. of the exciter rises slightly above that of the omnibus conductors. The same apparatus break circuit should the exciter begin to take current from the omnibus bars. A cast-iron switch-pillar, Fig. 17, is provided for each alternator, by means of which all the operations necessary for putting that machine in or out of circuit are performed. The pillars are fitted with three iron handles, which perform the following functions: the left handle puts the exciting current on to the field magnet; the right handle puts on the synchroniser; these two operations being performed, the middle handle, which operates the main switch, is liberated and can put the alternator on to the main feeders. The closing of the main switch locks the field switch, and turning off the synchroniser locks the main switch. There is an independent trigger on the main switch, which is released by the current attaining the normal voltage. This interlocking gear assures that the alternators cannot be switched in without being excited, or the exciting current broken while the main switch is closed. Each alternator switch-pillar is provided with a rheostat for correcting the temperature resistance of the field circuit, but it is not used for regulating the E.M.F. nor for varying the load on the machine. The leads from each of these alternator pillars are connected to the dividing tables shown in the centre of Fig. 18.







FIGS. 19, 20, AND 21.—Transformer Sub-Station and Outfit.

In this pillar, which is kept carefully locked to prevent any unauthorised person tampering with it, the alternators are coupled to the two sets of concentric mains supplying

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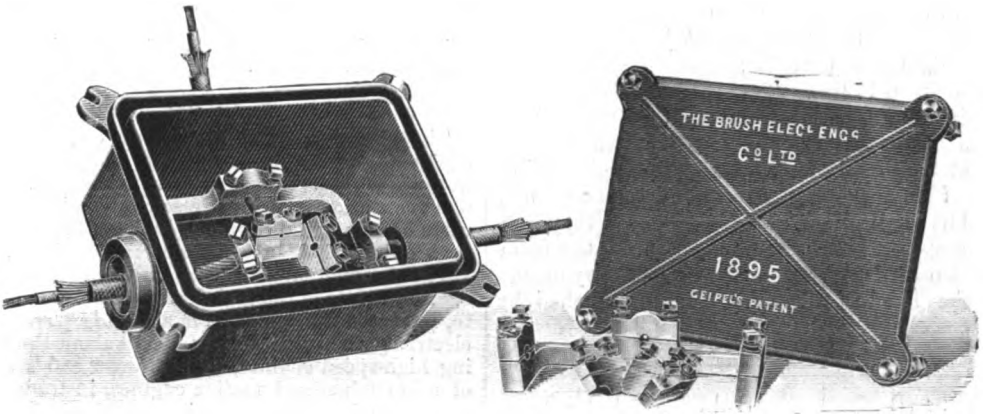
the town. Thus means are provided that two of the alternators can supply one half of the town through one feeder, while the other half is independently lighted by another alternator. This minimises the risk of total extinction of the lights, although we understand that in ordinary practice the whole of the alternators will run in parallel and supply through both feeders in parallel.

The control of the E.M.F. of the whole station, as measured at the omnibus tables, is effected by means of an electric circuit influencing the throttle-valve governors of the exciters. Each exciting engine has a solenoid arranged to act upon the adjusting lever of the governor; the speed of the engine can, therefore, be varied by varying the current in the solenoid. All the solenoids are in parallel on a circuit in which is placed a rheostat regulated by hand or automatic mechanism. It is part of the system that the controlling solenoids shall be always in circuit, so that no exciter can be started without being at the same time under the control of the switchroom. The action of the regulating circuit is to increase the speed of the exciter, so that in the event of the regulating circuit breaking down, the only effect would be that the E.M.F. would fall and would have to be raised by hand adjustment of the governors. No fuses whatever are allowed in the exciter circuits. All the main alternator fuses are of the Bates type, and the switches are immersed in water to prevent arcing.

The erection of the whole of the electrical plant has been superintended by Mr. J. J. Steinitz, on behalf of the Brush Company.

Distribution.

The system adopted is that of transformer sub-stations placed under the footpaths, each containing two or more transformers excited in parallel off high-tension mains, and feeding into a low-tension network from which private consumers are supplied. The transformer-chambers, Figs. 19, 20, and 21, are eight in number, their internal measurement being 7ft. 6in. long, 5ft. 6in. wide, and 7ft. high. The sides and ends are cambered, having a rise of 6in. The walls of the chambers are formed of good hard bricks in cement in two thicknesses, with an inch space between. This space is filled in with specially prepared asphalte, which is also continued under the paving of the floor as well as over the roof, thus making the chamber perfectly water and gas tight. The roof is formed of rolled-steel joists filled in between with cement concrete. A suitable manhole with double cover is provided for access to the chambers, which are descended by means of step-irons built into the inner thickness of wall. All the chambers have an air inlet and outlet for securing proper ventilation. The bellmouths of the pipes carrying the high-tension mains are caulked with Vulcan cement, with the object of preventing any gas finding its way into the chambers. As an additional precaution against accidents, the pipes are provided with a ½in. hole about 1ft. from the back of the wall of the chamber, which communicates with a ventilating flue. This arrangement allows any gas which finds its way into the pipes escaping before reaching the chamber. A similar arrangement with the same object is provided in connection with the low-tension cables.



FIGS. 22 AND 23.

The equipment of the sub-station is as follows, will be seen from the illustration:

(A) *Transformers.*—These are of the well-known Mordey-Victoria type. The all-day iron losses of one of these, as measured at Loughborough, shows the following excellent attainments:

Output	36,000 watts
Iron loss	281·4 watts = ·78%
Power factor	·74%
Total drop full load to no load	1·8%

(B B) Transformer switch-boxes.

(C) Joint-boxes for connecting the concentric cables in indiarubber lead. This box, which is Geipel's patent, is shown in detail in Figs. 22 and 23. The feature of the construction adopted is that, instead of having the inner conductors jointed at the same level as the outer, they are joined at a higher level, thus being more accessible, and can be disconnected without the necessity of removing the insulating compound from round the lower conductors.

(D) A similar joint-box, used in this transformer-chamber for a high-tension feeder not tapped.

(E) The air outlet for ventilation purposes. The air inlet and ventilation of the pipes can also be seen. The fuses are placed just above the transformers.

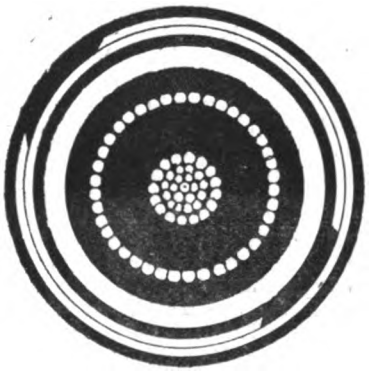
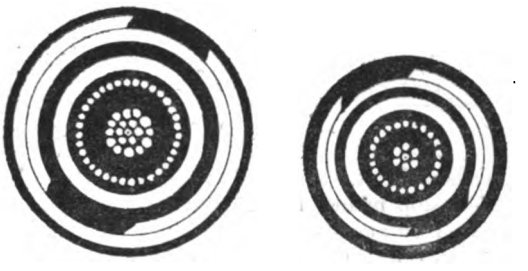


FIG. 24.—·146 sq. in. Cable, 37/·070 High-Tension Feeder.

FIG. 25.—·146 sq. in. Cable, 19/12 Low-Tension Main.



FIGS. 26 AND 27.—Low-Tension Sub-Mains and House Connections 19/17 and 7/16.

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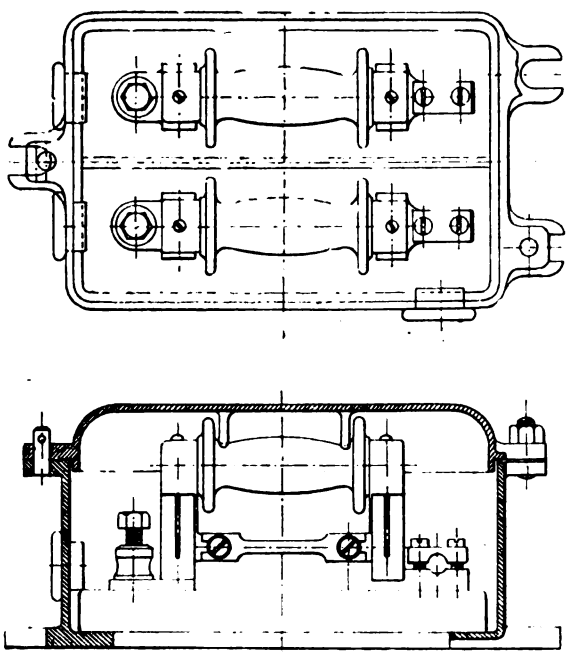
Mains.

All the cables used at Leicester are of Fowler-Waring manufacture, and for the street work are concentric, the outer conductors being earthed. Two main high-tension feeders run from the generating station in the Aylestone-road to the first transformer-chamber in Belvoir-street, a distance of 2,100 yards. They are buried in the sidewalk of the Aylstone-road 15in. below the ground. Each consists of a Fowler-Waring concentric cable, Fig. 24, the conductors of 100 per cent. conductivity copper with a sectional area of ·146 square inch highly insulated, lead-sheathed, and armoured with steel tape, with an external serving of jute soaked in compound. This high-tension cable withstood 8,000 volts in the works at North Woolwich, and 4,000 volts when jointed in position. The radial depth of fibre impregnated with hydrocarbon insulation is 0·174in. The thickness of lead is 0·115in. The insulation resistance was 3,500 megohms per mile. From the transformer-chamber at the corner of Belvoir-street and Market-street the high-tension mains consist of similar cables of ·097 square inch sectional area, but instead of being armoured, they are drawn into 3in. cast-iron pipes; these are laid in the form of a ring, any section of which can be disconnected by means of isolating switches fixed in the sub-stations, of which eight



FIGS. 28 AND 29.—House Service Box.

have been built within the compulsory area of supply. The low-tension mains, Fig. 25, having a sectional area of a ·146 square inch, are concentric, lead covered, and armoured, being laid direct in the ground, and connected together in one network. There are at present some 1,100 yards of armoured and unarmoured low-tension cable laid. House connections, Figs. 26 and 27, are made by means of concentric armoured cables jointed with wiped joints, which are protected by a tee-shaped casting. The Brush Company's new form of house service box, Figs. 28 and 29, is used on the consumers' premises; they include a double-pole switch and fuse specially arranged for connecting concentric service cables to separate house mains. The whole is enclosed in a cast-iron lock-up box of substantial design.

In conclusion, we most heartily congratulate the Corporation of Leicester on the well-equipped electric lighting station they now possess, at a cost well within the original estimate. We also congratulate the engineer, Mr. Colson, and the contractors on the success of their joint efforts, which have resulted in the production of such excellent work.

London Chamber of Commerce.—The thirtieth annual general meeting of the members of the Chamber of Commerce will be held in the council-room, Botolph House, on Tuesday, May 21, at 2.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS, May 9.

MR. R. E. B. CROMPTON (President) in the chair.

At the commencement of the proceedings, the **Chairman** referred to the loss which the Institution had sustained by the death of Major-General Stewart, C.B., R.E., who was one of the members of the Institution when it was the Society of Telegraph Engineers and Electricians, and moved a vote of condolence to his widow and other members of the family.

Captain Sankey, who seconded the motion, testified to the high esteem in which the deceased General was held by his brother officers and those who served under him.

The following paper was then presented:

ON THE RECENT DEVELOPMENT OF THE SINGLE-ACTING HIGH-SPEED ENGINE FOR CENTRAL-STATION WORK.

BY MARK ROBINSON, MEMBER.

The success of the high-speed engine in this country is amongst the notable engineering facts of the time. It relates, in the first place, to mechanical engineering, yet it also concerns this Institution, since it is electrical engineers who are the chief users of high-speed engines; to them, in fact, it is due that such engines hold their present important position.

The presidential address at the commencement of the present session, in which the high-speed engine was favourably referred to, produced the comment in a leading professional paper, that electricians had little cause to boast about their work in developing high-speed engines, for if they "had stuck to the builders of mill engines and marine engines, instead of trying to strike out a new line of steam-engines for themselves, electric lighting would have been very much the gainer." The judgment of electrical engineers has thus been arraigned before the general body of their brethren, and it may be useful to enquire with what justice.

According to what purports to be a full list of public lighting stations, published last January in one of the principal electrical journals, the indicated horse-power installed in all the lighting stations in Great Britain was 101,390. Of this, one make of single-acting high-speed engine accounts for 53,340 h.p., or more than all other patterns put together, and even of these last, more than 4,000 i.h.p. are high-speed engines of other kinds. Engines of the mill or marine pattern figure for little in the total, and as the high-speed engine started later than its rivals, its proportion of the more recent work is even greater than the above figures would indicate. Not much apology, therefore, is needed for bringing this subject before electrical engineers.

The preponderance of one type of high-speed engine, embodying many views in conflict with those upon which other engine practice is based, virtually obliges this paper to be both a description and a defence, and may even give to it the appearance of eulogy, of that particular engine. Few but those directly interested in the manufacture of a highly-specialised machine are so conversant with it and its history as to be willing to write upon it; hence such a paper risks the charge of partisanship, and is certainly open to that of prepossession. A well-remembered charm of the late Mr. P. W. Willans's papers upon steam-engine economy lay in the fact that his conclusions were as far as possible framed to apply to engines in general; his own engine, though in all cases the one tested, was scarcely described, and certainly unpraised. The present paper, on the other hand, if it is to have any practical value, must not only describe the Willans engine, but must deal almost exclusively with its difficulties, with its successes, and with its improvements. A description of the engine, with some notes on its history, is given in an appendix.

The advantages of single action and of high speed are, however, not limited to any one engine, and they may be described generally. An engine is "single acting" when the steam acts only upon one side of the piston, the typical case being James Watt's Cornish pumping engine, and this method of using the steam has certain economic advantages in which a double-acting engine cannot share. At equal speeds, however, they are neutralised by the fact that for a given power the cylinder capacity has to be twice as great in a single as in a double acting engine, and it is not until the single-acting engine runs at twice as many revolutions as its rival that it has much advantage. This it is usually able to do, since it can be worked upon the "constant-thrust" plan, which the double-acting engine cannot be—that is to say, the piston-rod can be kept pressing against the connecting-rod, and the latter against the crank-pin, not only throughout the working stroke, but through the return stroke as well; the working parts are thus always in compression, and never in tension. The cross-head pin presses always against the same side of the bush or brass in the small end of the connecting-rod; the big-end upper brass maintains constant pressure against the crank-pin, never leaving it even momentarily; the crank-shaft presses always against the lower main bearing brasses,

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never against the caps.* Of course a single-acting engine is not necessarily a "constant-thrust" engine, and special means have to be taken to make it so: the point is that these means are possible with a single-acting and are not possible with a double-acting engine, and though it is a view which is contested, it is the opinion of the author, and certainly it is a widely-held opinion, that really high speed and "constant thrust" should go together, unless in such a case as is referred to in paragraph 8.

High speed is at last recognised as a good thing in itself. A fast-running engine is, for a given power, smaller and lighter than a slow one, while a large number of small impulses per unit of time give a more even turning moment than a small number each of greater magnitude. By shorter exposure of the cylinder surfaces to successive changes of temperature, the loss by initial condensation is reduced, so that an unjacketed engine becomes as good as a jacketed one; and for many purposes, as where direct coupling to fast-running machines is required, and especially for dynamo driving, the high-speed engine has advantages which are of necessity admitted. Attempts to revive the belt-driving system in central stations, in the country which is the home of direct-driving, and after the rest of the world has almost unanimously come round to its views, will be endured in England only so long as shareholders and ratepayers remain ignorant of the waste of money it entails, while the proposal to make the naturally fast-running dynamo into a slow and enormously more costly machine, merely for the sake of allowing it to be driven direct by a slow-running engine, is not likely to meet with success in the long run. The future, however, can take care of itself; it is enough that high speed is already recognised as beneficial by all who are likely to mould future practice.

It is evident that a single-acting engine in which there is absolutely no back-lash and no reversal of stresses, and which is otherwise rightly proportioned, will run freer from wear in its brasses than a double-acting engine, at any but very moderate speeds. In the author's opinion, an ordinary double-acting engine is in danger of becoming troublesome, if it is run much more than one-third as fast as the speed at which a single-acting engine will run continuously and easily; will need very good design and careful attention if it is to run half as fast, and must be an altogether exceptional engine if it is to run two-thirds as fast without giving comparatively frequent trouble. There would probably be no difficulty in finding in use many single-acting engines of, say, 80 i.h.p. or 100 i.h.p., running at 450 revolutions per minute, which have had five years' service and upwards without one of the brasses being touched since the engine was first put to work; and it is a safe statement that if these brasses were now removed in most of them no wear would be detected without careful measurement, while if through unfavourable conditions of lubrication or otherwise appreciable wear were found, it would be absolutely without effect upon the good running of the engine. No such statement could be made of any double-acting engine; but for any purpose where the runs are limited to hours, or even to days, an ordinary double-acting engine of the same power would no doubt run at 150 revolutions without giving appreciable trouble. Such an engine, however, would have larger cylinder volume than the 450-revolution single-acting engine, and would suffer more from initial condensation, and it would hardly be trusted by most engineers for purposes (such as electrolytic work) in which an engine must run for many weeks, or even months, without stop. With special design, half speed, or 225 revolutions (giving equal cylinder volumes, but double exposure of the surfaces in each revolution), is also attainable by a double-acting engine; but few are likely to dispute the opinion that two-thirds speed—*i.e.*, 300 revolutions per minute—is not a desirable speed for an 80-h.p. double-acting engine required to run continuously for weeks or months together under commercial conditions. The author does not overlook the fact that double-acting engines are designed and made to run at even the fullest speeds of single-acting engines, and that by a combination of excellent design and workmanship with a system of forced lubrication (oil is forced into the bearings by pumps) they are able to do so. It would be out of place to refer here in detail to the author's reasons for disbelief in the ultimate acceptance of this ingenious and bold attempt to evade the natural difficulties which the case presents; it is sufficient to say that for the present the single-acting engine holds the field for high-speed work on the large scale, and, according to the most recent experience, with increasing success. Defining high speed as the highest speed which experience shows can be attained without visible disadvantage by a single-acting engine of a given power, it must be said that single action is not essential to high speed, but that it helps enormously to its successful attainment.

It may, nevertheless, be of interest to remark (though, in the author's opinion, the fact has no bearing upon electric lighting practice) that for the attainment of the extremest speeds, with large powers, a double-acting engine is to be preferred. The maintenance of constant thrust upon the brasses, which may be taken as the real essence of a single-acting engine, involves great difficulties when certain limits are exceeded, and if through any temporary reason the constant thrust is lost and the engine becomes double acting as to its brasses, there will be serious chances of rapid wear, and even of such hammering as to cause fracture. In a double-acting engine, on the contrary, provision is made from the beginning for the change of stress at the end of each stroke; it is a mere question of brute strength in the parts, and since they are always under observation for excessive wear, and periodical adjustments are a part of the system, there is little danger of serious damage. For torpedo boats and other cases where the greatest power must be obtained from the least weight, and where knock and frequent adjustment are comparatively unimportant, double-acting engines are plainly best. But few electrical engineers would care to entrust the continuous running of their stations to engines of this type, or to go through quite the same engine-room experiences as are rightly accepted on board a "catcher."

The class of engine called "high speed" in America is usually a double-acting engine, capable of running from one-half to two-thirds the speed of the corresponding single-acting engine of this country. As such it has already been referred to generally, and though it usually runs well, it has no claim to special consideration, certainly not on the ground of economy.

The effect of "single action" in lessening wear upon the brasses must be obvious, and the connection is almost as close between single action and the beautifully simple method of automatic lubrication by the splash of the cranks in an oil-chamber; the latter cannot be adopted without risk of much inconvenience, where brasses have to be under constant observation. The very small bearing friction which results partly from this system of lubrication, and partly from the absence of back-lash, is also unattainable in a double-acting engine.

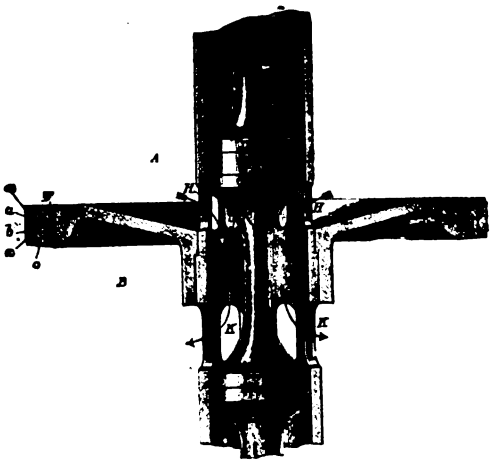

FIG. 1.—Vertical section through piston, showing rings *a* and *b*, which break joint; spring *c* for lightly forcing the rings outwards; spring follower plate F, with holes through it, admitting steam to the space behind the spring *c*.

So far only the general and more obvious advantages of the single-acting engine have been considered. Now it is proposed to describe in some detail three important features in the particular engine which has become, in this country at least, the type of the class; none of them have yet attracted as much attention as perhaps they deserve. They are: (*a*) the special system of packing rings for pistons, valves, and glands; (*b*) the special provision for internal drainage; (*c*) the Cornish cycle, or "transfer plan." All three are directly related to the single-acting principle. All, except the Cornish transfer, are peculiar to the Willans engine, and none of them could possibly be adopted in a double-acting engine. All are of high value in promoting steam economy.

Packing Rings (*a*).—One of Mr. Willans's latest improvements in his engine was the system of packing rings shown in Fig. 1, where A is the working end of the cylinder; the pressure in B, below the piston, is materially less upon the down (or working) stroke than that above it, but on the up or exhaust stroke it is practically the same: it is never less, unless in the exceptional case of a looped diagram. There are two rings, *a* and *b*, breaking joint, and turned of the same thickness throughout, which exactly fit the cylinder before they are divided; *c* is a cast-iron spring ring, turned eccentric and slightly too large for the cylinder: great care is taken to have true surfaces at *x*. The follower, F, is a thin steel plate, very slightly dished, so as to have a slight initial pressure upon the top of the rings. It is perforated, to let steam from A enter the space behind the spring, which it tends to push outward lightly during the up stroke, comparatively strongly during the down stroke. The rings are held against the lower flange of the piston body, G, not only by the spring follower, F, but by the steam pressure on the top of the rings; on the up stroke, when

* A single-acting engine can be run with the parts always in tension, and never in compression, with equal ease, but the contrary plan is practically the best.

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there is less pressure above the rings, their friction against the cylinder is sufficient to keep them seated on the piston body. It will be noticed in this system, first, that the outward pressure on the rings is relieved during the ineffective stroke; and, secondly, that the principle of "constant thrust" is applied to the rings as regards end-play. At all times, whether the piston moves one way or the other, and equally while it reverses its movement on the dead points, the piston rings are held closely down upon the piston flange, and there is none of that wear of the rings endways which tends to arise in all double-acting engines, owing to the friction of the rings causing them to lag behind, so that they are pushed one way

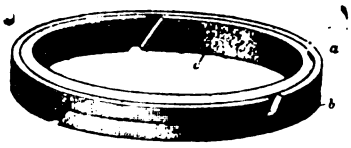

FIG. 2.—Perspective view of set of piston rings complete. Two rings, *a* and *b*, breaking joint, and spring *c*. The steam presses against the inner surface of *c*. NOTE.—The thickness of the rings is exaggerated relatively to their diameter, for greater clearness.

by the piston body and the other by the junk ring or follower. Even if wear arose (which under ordinary circumstances it cannot) the spring follower would follow it up: there would still be no hammering of the ring between the two sides of the groove. There is thus no increase of ring leakage; the longer the use, the tighter the rings. The piston valves are on the same system as regards constant pressure of the rings and other parts against each other, but they are not steam-packed (see Fig. 3). They are separated by suitable cast distance-pieces, with their ends faced to lie against the rings. All are strung together upon a steel tie-rod, with a kind of spring washer under the nut at the end. All parts are free to slide upon each other sideways; all are designed to be held together, without the possibility of hammering upon each other, by the pressure of the steam (in the steam-chest) upon the uppermost valve, aided by the spring washer referred to. The gland rings, used instead of stuffing-boxes (see Fig. 4), are upon exactly the same system as the main piston rings; they are simply piston rings pressing inwards instead of outwards, and guarded against end-play in exactly the same manner. Steam is admitted behind them, as in the main pistons.

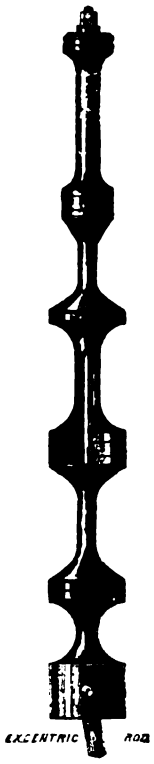

FIG. 3.—View partly in elevation, partly in section, of a line of piston valves from a compound engine.

This construction of the various piston and other rings is perhaps the most interesting application of the constant-thrust principle in the engine, but it has not been arrived at without long experiment and some changes. It was originally attempted to dispense with steam pressure behind the piston and gland rings—in fact, to exclude it—and many will remember the collapsing of the rings, especially when the steam was very wet, or when over-much oil was used. Under some circumstances a ring could always be set collapsing by increasing the oil supply: it is an old experience that water (or oil) will get behind a ring where steam alone will fail to pass. Once separated from the cylinder wall, the ring was bound to spring inwards, until stopped by the butting of its ends: this butting and the subsequent spring outwards caused much noise and wear, and sometimes breakage of the ring, with, of course, waste of steam. Instead of a spring-plate follower, there was at first a fixed follower—which allowed end-play, and so wear, as in other engines—and afterwards a solid follower pressed down by spring washers, which also was not satisfactory. When "steam-packing" was first adopted, the holes in the follower were not made large enough to let the full pressure in behind the rings in the short time available, and so the system was imperfect. These defects have been corrected, and the system seems now to be not only perfectly successful, but in a sense beyond rivalry; for it would evidently be impossible to apply it in a double-acting engine—that is, in an engine where the preponderance of pressure changes from one side of the piston to the other. It may be added that very careful measurement, based upon some three years' experience, shows that the wear in the cylinders is less than with the earlier rings, whose outward pressure was given entirely by springs. With rings which practically do not wear at all, and which are bound to keep tight whether they wear or not, it is not surprising that the economy of the engine increases with use.

Drainage (*b*).—The best-drained double-acting engines are probably horizontal engines with separate Corliss or similar exhaust valves beneath the cylinder. The water lying on or draining down towards the cylinder bottom is pushed along by the piston until it reaches the exhaust-port, but unfortunately

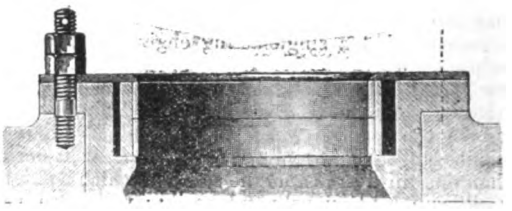

FIG. 4.—Sectional view of a steam gland box.

only just before the moment of closing; however, it fills the port, and lies in it until the exhaust opens again—ready, it is to be feared, to rob the incoming steam of some of its heat during the next admission, and so to increase initial condensation. In vertical engines, at the bottom end of the cylinder the drainage may act continuously, so far as gravity can effect it, during the whole exhaust stroke, but at the upper end the water will rest on and be carried up by the piston until it rises above the port, when, as in the horizontal engine, only a very brief time is available for it to run away; much water probably lies permanently upon the piston, with injurious results from the point of view of initial condensation. If the exhaust-port is also the admission port, the water cannot even lie there until the next exhaust; it is thrown back into the cylinder by the incoming steam. In none of these cases is the drainage satisfactory.

The drainage arrangements in the Willans central-valve engine offer a striking contrast to the foregoing (see Fig. 1). The piston is dished downwards in the centre, not so much with the idea that the water lying on the piston will drain into the centre by itself, but to utilise the inertia of the water to drive it towards the centre during the rapid up stroke of the piston. There is a ring of ports, H H, in the trunk or hollow piston-rod, flush with the surface of the piston, and of course moving with it, and during the whole exhaust stroke there is a rush of steam from the sides towards these ports in the centre, sweeping over the face of the piston and assisting the action last referred to. In fact, the exhaust-port is always in the best possible place for drainage; it is as though the exhaust-port in the horizontal Corliss engine moved along the cylinder bottom so as to be always just ahead of the piston. The water is out of the cylinder before the port closes, nor is there any clearance space in the port—that is, between the cylinder and the valve—where it could lie; there is practically no clearance. It is an ideal exhaust arrangement, and there is no apparent possibility of applying either it, or anything else as good, to a double-acting engine. It is probable that it involves a saving of about 15 per cent. in the steam consumption in comparison with other vertical engines in which ordinary slide or piston valves are used common to admission and exhaust. In Fig. 1 the central valve, L, is shown in its relatively highest position; the exhaust steam (and water) are passing away into the space B, as shown by the arrows, through the ports H H and K K. B is, of course, the receiver; it is in one sense the exhaust-chamber of the working cylinder, A, in another sense the steam-chest of the succeeding cylinder, if there be one. It will be understood that when the valve, L, is below the ports, H H, steam passes into the cylinder from the upper part of the hollow piston-rod.

The "Cornish Cycle."—In the Cornish single-acting pumping engine the steam acts only on the top of the piston, the space below being at the time in communication with the condenser.

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To develop the power of the engine it would only be necessary to open communication during the up stroke between the upper end of the cylinder and the condenser, and to maintain communication permanently between the lower end and the condenser: the piston would ascend *in equilibrio*, with vacuum on both sides of it. Viewing the upper end of the cylinder by itself, this is exactly what takes place in every ordinary double-acting engine, and the whole arrangement described, including permanent vacuum below the piston, is the most obvious and natural arrangement for a single-acting engine. In Watt's Cornish engine there is, however, another valve which cuts off the space below the piston from the condenser, at the moment when the steam above the piston commences to exhaust, and the exhaust takes place from above the piston into the space below it, and not direct to the condenser; the piston still ascends *in equilibrio*, but with higher pressure steam on each

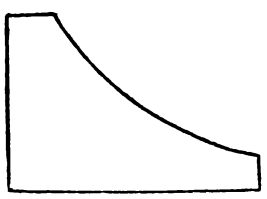

FIG. 5.

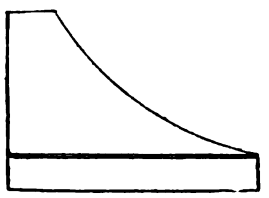

FIG. 6.

side of it. By this system Watt raised his pumping engine to a pitch of excellence never attained by his later double-acting engines; in fact, so economical (for a simple engine) is the old Cornish engine that in the controversies attending the introduction of the modern compound engine, the former was quoted to show that a simple engine could work as economically as a compound. The claim was excessive, except at very low pressures, but neither side realised that the Cornish engine is not a simple engine—it is half-way to a compound. Fig. 5 is a theoretical diagram from a simple engine in which the working cylinder opens alternately to the boiler and to the condenser. If it is also single-acting, and advantage is taken of that fact to introduce the Cornish cycle, the two diagrams given in Fig. 6 are obtained from the two ends of the cylinder, instead of the single diagram in Fig. 5. There is the same expansion in a single cylinder, but the range of temperature in it is only from admission temperature to release temperature, and not to condenser temperature. In other words, though the expansion is in one stage, the fall in temperature is divided over two; hence a great reduction in initial condensation, and marked economy.

(To be continued.)

DISCUSSION.

The **Chairman**, in opening the discussion, said that the great progress in electrical engineering dated from the time that Mr. Willans invented the high-speed engine.

Mr. Raworth said that he did not quite agree with Mr. Robinson in considering that electricity would not have advanced so rapidly as it had done but for his engine. He was a very great admirer of the enclosed engine. There were many single-acting engines before the Willans engine, which dated back to 1874. He could remember the time, in the early days of electricity, that Mr. Brotherhood's engine was greatly in demand by electrical engineers. Mr. Willans was stimulated by this fact. The speaker had not been greatly indebted to the builders of mill engines. His experience has been that in every instance they had entirely failed to grasp the situation. When he was an apprentice the same battle between the horizontal slow-speed engine and the beam engine was taking place as was now occurring between the vertical high-speed engine and the horizontal slow-speed engine. He greatly admired the Willans engine. It had some extremely good points, and he had used some with very great success. Mr. Robinson had treated of some points in its internal construction on which we were previously ignorant. This ingenious machine had one drawback—a rather serious one—it was a Chinese puzzle. You could not take out any one of the parts in order to see whether that part was in proper order or not. He did not concur with Mr. Robinson on the subject of wear. He gave Mr. Robinson credit for the improvements he had introduced into the engine since Mr. Willans decease. An ordinary vertical engine properly constructed would, he said, run with as great efficiency as, if not greater than, the Willans engine. An ordinary Tangye engine would give from 90 per cent. upwards in brake efficiency, but this would not be so in the case of a horizontal engine. He considered that the high speed of the Willans engine was not due to the constant thrust, but to the short stroke. He, however, heartily agreed that electrical engineers were greatly indebted to Messrs. Willans and Robinson for the specially highly-developed machine which they had put into their hands.

Mr. W. H. Booth stated that in his paper Mr. Robinson had referred to the overlapping of temperature ranges in the ordinary engine which did not occur in the Willans engine. He thought this was not quite right, and on the blackboard showed diagrams of different types of engines. In the ordinary engine there was no overlapping if properly designed and properly set.

Mr. Carter stated that the same point had occurred to him, and gave a diagram to show that the fluctuation of temperature ranges in the Cornish engine did not take place in two cylinders.

Mr. Bailey said that the relative cost of the different methods of driving were not what might have been supposed. He had, on behalf of the Government, called for tenders for an engine and dynamo. He received offers, from firms who all turned out good work, for a slow-speed horizontal engine and dynamo, a comparatively slow-speed vertical engine and dynamo, and for a high-speed engine and dynamo. It might have been thought that the last named as being the smallest would have been the cheapest, but this was not the case. The dearest was the slow-speed, and the cheapest was the medium vertical engine and dynamo.

The discussion was then adjourned.

There was on view a zero-torque electricity meter, invented by Mr. Joseph Edmonson, a description of which was circulated.

The following is a list of the candidates balloted for:

Foreign Member.—Don Rafael Casado, Valladolid, Spain.

Member.—Stanley Bright, Tilbury Dock, Essex.

Associates.—Cornelius Francis Fielding, 89, Patrick-street, Cork; Adam Rutherford, 14, Hill-street, Garnet Hill, Glasgow, N.B.; Rigby Wason, 8, Sussex-gardens, London, W.

Student.—John Harold Wray, Cemetery Lodge, Blackpool.

WHAT, WHEN, AND WHERE.

Institution of Electrical Engineers.

May 17, 8 p.m.—Students' Meeting in the Library of the Institution, 28, Victoria-street. "Aluminium," by Gerald C. Allingham.

Royal Institution, Albemarle-street, Piccadilly, W.

May 10, 9 p.m.—"A Recent Journey in Afghanistan," by the Hon. G. N. Curzon, M.P.

May 11, 3 p.m.—"Italian Musical Instruments of the 16th, 17th, and 18th Centuries," by Arnold Dolmelsch.

May 14, 3 p.m.—"Thirty Years' Progress in Biological Science," by Prof. E. Ray Lankester.

May 16, 3 p.m.—"The Liquification of Gases," by Prof. Dewar.

Society of Arts, John-street, Adelphi, Strand.

May 13, 8 p.m.—Cantor Lecture by James Douglas on "The Recent Metallurgy of Copper, Lead, Gold, and Silver in America." Lecture IV.

May 15, 8 p.m.—"Means for Mitigating the Fading of Pigments,' by Captain W. de W. Abney, C.B., F.R.S.

Physical Society, Burlington House.

May 10.—"The Iodine Voltmeter," by E. F. Herroun. "A New Method in Harmonic Analysis," by A. Sharp.

Northern Society of Electrical Engineers.

May 13, 7 p.m.—At the Palatine Hotel, Hunt's Bank, Manchester, Council meeting; 8 p.m., special general meeting; 8.30 p.m., ordinary general meeting. Paper on "The Uses of Accumulators," by J. C. Howell.

North-East Coast Institution of Engineers and Shipbuilders.

May 14, 7.30 p.m.—In the Lecture Hall of the Literary and Philosophical Society of Newcastle-upon-Tyne. Closing business meeting of the session. The discussion on Henry Foster's paper on "The Application of the Electric Arc to Machinery, Boiler Repairs, etc.," will be concluded. The discussion on S. O. Kendall's paper on "Turret-Deck Cargo Steamers" will be concluded. The discussion on G. H Baines's paper on "The Metric System of Weights and Measures (a Plea for its Adoption in the United Kingdom)" will be resumed by Colonel A. Robson, who will move a resolution in favour of the adoption of the system.

Cheltenham.

May 16.—The Corporation will take over the central electric light station from Messrs. Siemens, and a dinner will be given by Alderman Norman, chairman of the Electric Light Committee.

Electric Traction at Oporto.—The first town in the Peninsula to have an electric tramway will, it is said, be Oporto, and the contract for it has been secured, over the heads of German competitors, by the French Thomson-Houston Company. The city authorities have insisted that the first trial shall be made on the line which presents the greatest difficulties, one on which the gradients are as heavy as 1 in 10, and the curves are numerous. The length of the line is about two miles. There will be three carriages, each fitted with two 25-h.p. motors, current for which will be supplied by a 100-kilowatt dynamo driven by a Farcot engine of 150 h.p. The central station is well on its way towards completion, and the line will shortly be laid

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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EDUCATION.

The question of the best means of becoming conversant with the subjects covered by the term "electrical engineering" is yet to be settled on hard-and-fast lines. Most of the men now holding high positions in the profession have been self-educated. Owing to the rapid developments of the industry, it follows that the men actually engaged in improving the various details know far more of the subject than most of the authorised teachers. The vast amount of information to be acquired by a young man now entering the profession necessitates some system of teaching beyond the workshop practice. We hold that without the shop practice, and subsequent training in the treatment of the commercial problems met with in daily practice, no man can become an electrical engineer. But we also maintain that the man who confines himself to his own particular work, and considers that he knows everything, will rapidly become a drag on the industry. What is needed is a careful study of the first principles of electricity and magnetism, with special reference to their application and practice. The instruction given under the Science and Art syllabus is doubtless good in its way, but a glance at the questions set in this examination will show that they are on subjects not useful to the electrical engineer. The questions as to the coupling of primary batteries to obtain maximum current, the behaviour of floating corks pierced by magnetised needles, and the relative advantages of cat-skins and silk in the production of electricity will afford harmless recreation to many, but very little bread and butter. No doubt the gentleman who excels in these intricate problems may make a living teaching others, but dynamo-makers or central-station engineers would not value that knowledge at twenty shillings a week. The City and Guilds of London Institute have come to the rescue, and by giving grants have created a new system of teaching, which is of great service to the young men employed in the electrical industries. This institute has at different times retained the services of such men as W. H. Preece, Gisbert Kapp, Silvanus Thompson, and James Swinburne as their examiners. These gentlemen, who have had great experience in the profession, usually set what we consider to be common-sense, practical questions. The men who have acquired the information necessary to successfully pass these examinations are fitted to attack any ordinary trouble that may occur to machinery under their charge. They must also have a good knowledge of the steps by which the perfection in the various details of electrical machinery have been arrived at, and also the reasons why certain supply companies pay dividend while others do not through the defective systems employed. We also know, from the reports of the examiners to the institute, that the answers sent in do improve in quality year by year. This shows that by requiring a high standard of marks for a pass, the teachers themselves have been spurred on. One thing we believe would make these examinations more useful to young electrical engineers, and that is a report to them of the errors found in the answers. To do this individually would be

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impossible, except at great cost, and the erroneous notions common to, say, 20 per cent. of the students on any one question might be noted. We wish the City and Guilds of London further success in their educational efforts.

It has been suggested to us that as the City Guilds have supplemented the Science and Art examinations, so it is possible for us to supplement both. With this object in view, we have resolved to extend our sphere of operations. Hitherto we have given the questions, and recently the answers to some of the questions. We now invite our readers—and especially our student readers—to send us the answers to any one section, and have arranged with the gentleman who obtained the silver medal in the honours grade in 1892 to adjudicate upon the solutions, and to comment upon the errors most frequently arising in these answers. It is with some diffidence that we offer to the gentlemen whose answers we print an acknowledgment of their success in the shape of books, but we think this will not be taken as an introduction of the guessing prize system into technical literature. Of course it is understood that the answers sent in are the sole work of the gentlemen who send them. It seems to us that a professional commentary upon the answers ought to be of great advantage to students. Hitherto they pass or they fail, and few ever realise the points upon which they and the examiners differed.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CITY AND GUILDS EXAMINATION.

SIR,—In taking Mr. Howard's figure for the cross-section of the cable, you must have overlooked the fact that he had worked out the problem as though the resistance was proportional, instead of inversely proportional, to the sectional area of a conductor.

As some of our younger friends may be not a little puzzled at the discrepancy of the answers given by the contributor and Mr. Howard, I thought it would be of interest if the full working of the problem was shown, so have done so.

(*a*) Total current required $= \frac{2,000}{10} = 200$ amperes.

Permissible drop = 2 volts.

Resistance of conductor $= \frac{\text{drop in volts}}{\text{amperes}} = \frac{2}{200} = \cdot01$ ohm.

(·01 ohm will be the resistance of 2,000 × 4 = 4,000ft. of mains—lead and return.)

Resistance of a conductor varies directly as the length and inversely as cross-section.

Resistance of Cu bar 4,000ft. long = ·008 × 4 = ·032 ohm.

Then as ·01 : ·032 :: 1 square inch : *a* square inch = 3·2 *square inches.*

(*b*) Current supplied from middle = 100 amperes.

Drop as before = 2 volts.

Resistance $= \frac{2}{100} = \cdot02$ ohm for 2,000ft. of main (lead and return).

Resistance of 2,000ft. of Cu bar = ·008 × 2 = ·016 ohm.

Then as ·02 : ·016 :: 1 square inch to *x* square inch = ·8 *square inch.*

The answers point out very clearly the advantage of placing the plant as near the centre of supply as possible.—

Yours, etc., HALDANE G. COTSWORTH,
Lecturer in Electrical Engineering,
North Wilts. Technical School, Swindon.

SIR,—Your solutions of the City and Guilds of London examination papers are very much appreciated by a numerous section of your readers, but as the answers to No. 6 appear to me incorrect, I offer the following, feeling sure there are many who will be expecting something more to be said on the subject.

(*a*) 2,000ft. × 2 = 4,000ft. frontage.

$\frac{4,000}{10} = 400$ amperes required.

$\frac{400}{2} = 200$ amperes average current.

200 R = 2. R = ·01 ohm.

$\cdot008 \times \frac{4,000}{1,000} = \cdot032$ resistance 4,000ft. of 1in. area.

$\frac{\cdot032}{\cdot01} = 3\cdot2$ area (square inches).

(*b*) $\frac{2,000}{10} = 200$ amperes each way.

$\frac{200}{2} = 100$ amperes average current.

100 R = 2. R = ·02 ohm.

$\cdot008 \times \frac{2,000}{1,000} = \cdot016$ resistance 2,000ft. of 1in. area.

$\frac{\cdot016}{\cdot02} = \cdot8$ square inch.

Yours, etc., ALEX. WROE.
93, Casella-road, New Cross, S.E., May 7, 1895.

SIR,—In looking over this week's *Electrical Engineer* I noticed a correction by Mr. Henley L. Howard of a City and Guilds examination question.

The proper solution is—

Total current required = 200 × 2 amperes (*i.e.*, calculating return wire) = 400 amperes.

$$R = \frac{E}{C} = \frac{2}{400} = \cdot005 \text{ ohm.}$$

·005 : ·016 :: 1 : *x*

= ·005) ·016 (3·2
15
10
10

Sectional area = 3·2 square inches.

Mr. Howard makes the mistake of saying that the resistances are proportional to the areas instead of inversely proportional. Thus he says

·016ω : ·01ω :: 1 : *x*,

instead of ·01 : ·016 :: 1 : *x*.

This latter gives 1·6 square inches. Now multiply by 2 for the two wires, then

1·6 × 2 = 3·2 square inches.

Yours, etc., HUGH G. MCHAFFIE.
Eastwood, Thornliebank, Glasgow, May 7, 1895.

P.S.—Of course, in case (*b*) the section is only half that of case (*a*)—viz., 1·6 square inches.

SIR,—I still think that there is an error in the answer given to Question 6 of the City and Guilds examination published in this week's *Electrical Engineer*. I have worked it out several times and get the following result:

(*a*) The mean current along street = 100 amperes;

$\therefore 100 \times r = 2 \therefore r = \cdot02$ ohm.

The resistance of 4,000ft. of one square inch of copper = ·032 ohm;

$\therefore$ ·02 : ·032 :: 1 : *x*;

$\therefore x = 1\cdot6$ square inches.—*Answer.*

Similarly—

(*b*) $50 \times r = 2$;

$\therefore r = \cdot04$ ohm.

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The resistance of 2,000ft. of one square inch copper = ·016 ohm ;

$$\therefore \cdot 04 : \cdot 016 :: 1 : x;$$

$$\therefore x = \cdot 4 \text{ square inch.}—\textit{Answer.}$$

Yours, etc., G. M. SHEPHERD.

Brockley, May 5, 1895.

[This question is raising much interesting discussion. We would point out to Mr. Cotsworth that 200 amperes is the maximum value of the current, and when the mean value is taken—*i.e.*, 100 amperes—the resistance of the line equals 0 02 ohm. Mr. Wroe takes the word "frontage" to mean both sides of the street, which we consider is rather a liberal reading of the question, but his answer is correct under that assumption. Mr. H. G. McHaffie's calculation and assumption are not easily followed, but his footnote, that the section, when the current is supplied midway, is half that when supplied from one end, is decidedly wrong. Mr. G. M. Shepherd is correct in his reply, and would take full marks for his answer.—ED. *E. E.*]

CITY AND GUILDS OF LONDON INSTITUTE.

ANSWERS TO THE QUESTIONS IN ELECTRIC LIGHTING AND POWER TRANSMISSION.

ORDINARY EXAMINATION, 1894.

(Continued from page 505.)

4. State relative advantages and disadvantages of the two following systems of distributing alternate currents: (a) transformers in consumers' houses, (b) transformers in sub-stations.

The advantages of placing transformers in consumers' houses are as follow:

(1) In straggling districts the great cost of low-tension mains of sufficient area to give constant voltage is thus avoided.
(2) Reasonably constant voltage is provided.
(3) Each consumer gets a direct supply with any chances of failure through faults in sub-station or on low-tension mains.

The disadvantages of this system are mostly on the side of the company providing the light:

(1) Each transformer must be ample to supply the maximum demand of the consumer it supplies. Hence aggregate power of transformers to be provided is excessive.
(2) This gives an excessive no-load loss, especially as small transformers are less efficient than large ones.
(3) The prime cost of transformers is more, but the total cost is less than with the sub-station system and low-tension mains.

The advantages of the sub-station system are as follow:
(1) The total power of transformers is less.
(2) The transformers are worked at more even loads, and hence more economically.
(3) The transformers in themselves are more efficient.
(4) No high pressure in consumers' houses.

The only disadvantage of this system is that of cost, which forbids its use in any but well-populated districts, where there is good demand for light.

5. Give full-size hand-sketch of a commutator, 6in. in diameter, 4in. face, showing in section how the plates are supported and insulated.

This can be obtained from any good text-book on the subject.

8. Sketch the connections of a Wheatstone's bridge, showing how it is connected to the resistance to be measured (See Fig. 8.)

I. Shows theoretical diagram.
II. Wheatstone's bridge—box form.
III. Thick copper strips for connecting up resistances to be measured.

11. State the circumstances under which it is economical to work glow lamps above their normal voltages.

The normal voltage of a glow lamp is the pressure required to give the nominal candle-power of the lamp, and if it is desired to obtain the maximum amount of light for a given amount of electrical energy, it is economical to work above the normal voltage, as the light produced increases as the sixth power (approximately) of the pressure in volts, whilst the consumption of the energy being only as the second power. The objection to increasing the normal efficiency of the lamp in this way is that the life of the lamp is diminished enormously. Prof. Ayrton, from a prolonged series of experiments, has shown that it is cheaper to burn a glow lamp for 200 hours at 104 volts than for 600 hours at 100 volts.

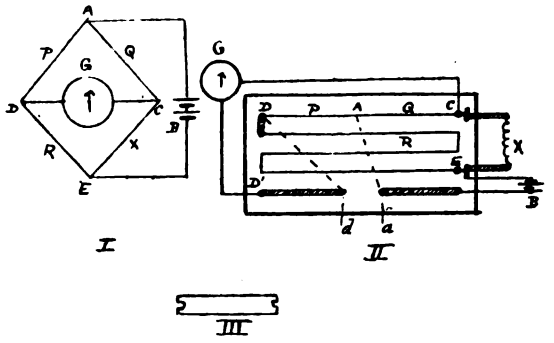

FIG. 8.

It is also advisable, if the cost of the energy is low, to increase the pressure above the normal after the lamp has been used for, say, 200 hours at the normal pressure, since with time the resistance of the filament increases, and the light decreases. In this case the normal efficiency is maintained throughout, and the additional expense for energy is almost counterbalanced by the saving in the cost of early renewals.

12. What rules govern the design of motor-generators? Upon what does the speed of them depend?

A motor-generator, or continuous-current transformer, differs from an ordinary generator in that the armature is wound with two sets of coils—the primary and secondary. According to theory, the *coefficient of transformation*, p, is equal to the ratio of the number of turns on the two coils—thus, $p = s_1/s_2$. The following rules govern the design of motor-generators:

(1) The quantity of copper in the primary coil should be equal to that in the secondary.
(2) The voltages are proportional to the number of armature-turns on the primary and secondary.
(3) The sectional areas of the windings should be proportional to the number of amperes, since the number of ampere-turns of the primary should equal the number of ampere-turns of the secondary.
(4) The coefficient of transformation is independent of the speed or the strength of the field used.

The speed of the generator depends on the strength of the field magnets and on the primary voltage.

13. Describe and sketch some form of automatic cut-out for series arc lamps, and explain its working.

All series arc lamps require an automatic cut-out, so that if the lamp refuses to work the current may be shunted round the lamp, so that the rest of the circuit is not interfered with. In the sketch, the feeding and striking mechanism is represented diagrammatically by the coils A and B. The coil A carries the main current for producing the arc, whilst the coil B is a shunt to A. The part, however, which we have to consider is the automatic cut-out shown at C. This consists of an electromagnet wound with very fine wire, placed in shunt between F and the negative terminal. F is the point where the main current enters the positive carbon-holder, and when from any reason the lamp fails to work, the pressure between the terminals of the electromagnet, C, becomes great enough to send sufficient current through C to mag-

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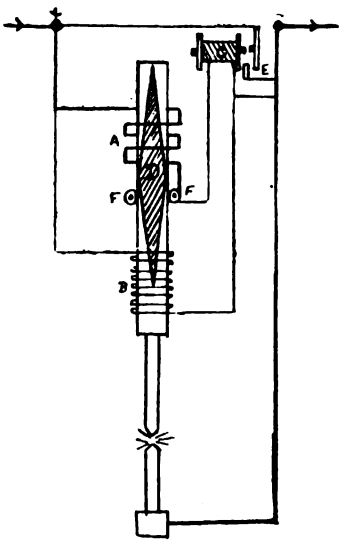
netise the core to such an extent that the armature, E, is attracted, and a spring automatically closes the circuit. This cuts the lamp out, as it will be noticed that the armature is connected to the positive terminal of the lamp.



14. Give the number of storage cells required for a 100-volt private house installation. Also state maximum charging voltage, and say how many cells must be connected with the regulating switch.

The least number of cells required for a 100-volt private house installation is 54, and since the pressure at the beginning of the discharge is slightly in excess of two volts, 50 cells will probably maintain for some time a pressure of 100 volts at the terminals of the most distant lamp. It must not be forgotten that there is a gradual drop in the pressure along the mains, the excess over 100 volts given by the 50 cells being required for this purpose. Five cells—*i.e.*, the 50th, 51st, 52nd, 53rd, and 54th cells—must be connected to the regulating switch, so that an extra cell may be switched in immediately, should the pressure fall below that required for the lamps. In charging, $2\frac{1}{2}$ volts must be allowed for each cell, so that the maximum charging voltage is $2\frac{1}{2} \times 54$, or 135 volts.

POINTS OF INTEREST IN THE DEVELOPMENT OF ELECTRICITY SUPPLY AT BRIGHTON.*

BY ARTHUR WRIGHT, ELECTRICAL ENGINEER, BRIGHTON ELECTRICITY WORKS.

Perhaps the title the author has chosen may, at first sight, appear to assume too much, but he trusts he will be able to interest the majority of the members by acquainting them with certain facts connected with the gradual development of electricity supply in Brighton, especially when he states that, as far as he has been able to determine, Brighton was the first town in England (1) to possess a central station erected for the express purpose of supplying the general public with electricity; (2) in which the inhabitants had the opportunity of paying for the electricity they actually consumed; (3) to have the advantage, or the reverse, of having had electricity supplied by more than four distinct systems of electric distribution during the last 10 years; (4) to have been the first town to adopt a differential system of charging for the electricity consumed, based on the actual cost of supplying it to each individual customer; (5) in which electricity has been supplied from one central station, both by the continuous and alternating systems of distribution simultaneously.

The author proposes to briefly relate the principal facts in connection with the first three of the above statements, and to deal more fully with Nos. 4 and 5, as these two last features of the Brighton supply system will probably have the most interest for the members. The chief points in connection with the history of the development of the electricity supply in Brighton are the following: In 1881 the Brighton Corporation instituted some arc lighting experiments on the Marine-parade; the cost, however, of running the machinery made the magnificent illumination then obtained far too great a luxury for it to be continued. At the end of the same year Messrs. Hammond and Co. decided to give the inhabitants of Brighton an opportunity of trying the electric light on their own premises, and for this purpose the author was instructed to erect a small plant and to run the necessary overhead wires. As far as he can learn, this was the first attempt in England to offer the general public an opportunity of having the electric light without having to incur the expense and nuisance involved in putting down generating plant on their own premises. The machinery was placed in Messrs. Reed and Sons' foundry yard in North-road, and overhead wires were run from this point to the principal business thoroughfares. The supply was started early in February, 1882, and since that time the inhabitants of Brighton have always had an opportunity of using electricity and becoming acquainted with its many advantages. It is partly to this long acquaintance with the electric light, among other things, that the recent rapid extension of its use in Brighton is probably due. For the first 16 months after the station was started only arc lamps were supplied, and these were charged for at fixed rental per month until April, 1883, when it was recognised that it would greatly add to the economic working of the supply station to charge for the lamps in proportion to the length of time they were burnt, and in that month was started the system of charging the consumers on a sliding scale system, based on the use they made of the generating plant. As there were no meters in existence then capable of measuring the current, the plan was adopted of determining the consumption by means of the number of carbons burnt. Reference will be made later to the exact terms of the sliding scale adopted. In June, 1883, incandescent lamps began to be supplied from the same high-tension mains as the arc lamps. The system of supplying them is now generally known as the multiple-series system. These lamps were charged for at a fixed rental until April, 1884, when electrolytic meters were devised to actually measure the consumption of electricity by these incandescent lamps. The current consumed in them, as measured by the meters, was charged for on a similar differential basis. In 1885 the Brighton business of the Hammond Company was turned into a separate joint-stock company, and began paying regular dividends in 1886. The business gradually grew, notwithstanding the high rate of charge adopted, equivalent in most instances to about 1s. 4d. per Board of Trade unit. In 1888 the high-tension continuous-current system was replaced throughout the town by the high-tension alternating-transformer system. The change over was effected by means of installing storage battery stations, and charging these by the high-tension continuous current. The greater simplicity of the transformer system gave another great impetus to the business, and when the author resigned his position as engineer to the company in 1889, the capital amounted to about £12,000, and the annual sale of electricity was at the rate of 120,000 units. After that date the business went on increasing to the extent of selling 140,000 units per annum until the year 1891, when in September the Corporation electricity works started supplying electricity on the two-wire low-tension system. When, early in 1893, the result of the Corporation's first year's working was to show that with even on the admittedly inefficient two-wire system electricity could be supplied from a well-organised station to yield a small profit at 7d. per unit, the ultimate extinction of the old company became inevitable, and negotiations were soon commenced for the purchase of the goodwill of the company by the Corporation; the result being in the following year the company's customers were transferred to the Corporation's mains. In 1893 the Corporation, recognising that the two-wire system could never be capable of supplying economically the whole of the borough from their one station, and the greater efficiency of the three-wire system, converted their entire system to the latter form. In the same year they carried out the electric lighting of the King's-road, which work constituted, so the author is informed, the first piece of street-lighting by means of arc

* Paper read before the Association of Municipal and County Engineers at Brighton on May 4.

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lamps run from the ordinary low-tension distributing mains. In 1894 the Corporation extended the distributing mains in all directions of the borough, and put down a high-tension alternating plant for supplying the purely residential districts in the north of the town. It is in these districts that the unique system has been developed of supplying electricity at light loads by the continuous current, and at heavy loads through the medium of high-tension alternating feeders. Something will be said about this special feature presently.

The following two tables, which are based on the latest published results of most of the central electricity supply stations in the United Kingdom, prove that in 1894 the actual cost, exclusive of redemption and interest of supplying electricity from the Brighton Corporation's station was less than from any other central station in Great Britain, and that the sale of electricity per inhabitant, taking all the towns having more than 50,000 inhabitants, was greatest in Brighton. When it is recognised that at the end of this year the capital sunk in the Corporation electricity works will probably reach £160,000, that nearly a million units will be sold during the year, that most of the principal streets will be electrically lighted, and that the annual consumption of electricity per inhabitant will in all probability reach the high figure of eight units, the members will see how rapidly the electricity undertaking is developing.

ACTUAL COST IN PENCE PER UNIT, EXCLUSIVE OF REDEMPTION AND INTEREST FOR THE SUPPLY OF ELECTRICITY FROM THE VARIOUS SUPPLY STATIONS.

Brighton	2·3
Liverpool	2·46
Strand and Charing Cross Company	2·58
Bradford	2·57
Newcastle	2·6
Westminster Electric Supply Company	2·69
Hull	2·86
Kensington	2·86
St. James's and Pall Mall	2·94
Manchester	3
Leeds	3·11
Birmingham	3·54
City of London	3·72

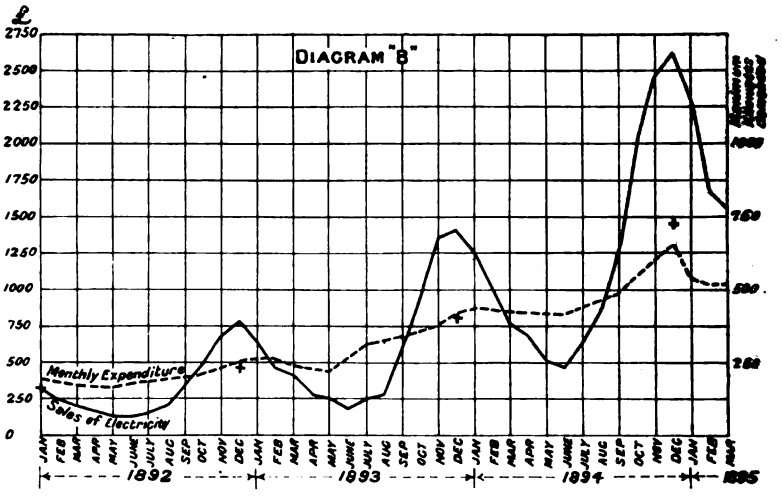
If the members will extend their indulgence a little longer, the author proposes to go somewhat fully into the two most distinctive features of the Brighton Corporation electricity supply—viz., the method of charging for electricity consumed, and the system of distributing it in the residential scattered districts.

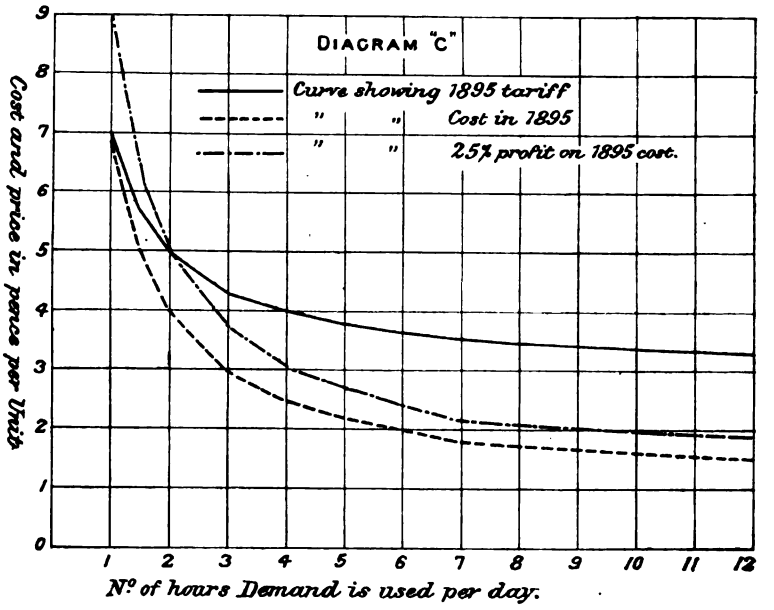
ANNUAL SALE OF ELECTRICITY IN UNITS PER INHABITANT IN THE TOWNS OF OVER 50,000 INHABITANTS OF THE UNITED KINGDOM.

Brighton	4·93
Newcastle and its districts	4·12
Bradford	2·22
Preston	2
Liverpool	1·96
Dublin	1·41
Bristol	1·32
Glasgow	1·25
Manchester	·87
Birmingham	·81
Hull	·8
Leeds	·75
Sheffield	·55

It does not seem to be sufficiently well recognised among engineers that the cost to electricity supply stations of continuing to produce electricity after everything has been put in a state of readiness to do so constitutes an extremely small proportion of the total expenditure. In order to make this truth more clear to the members the author is enabled to state, from the experience of the last three and a half years' working of the Brighton Corporation station, that the cost of having to be ready to supply electricity in Brighton in 1895 will probably amount to 80 per cent. of the total annual expenditure; the Diagram B will show clearly how very slightly the total monthly cost of running the Brighton station since January, 1892, to the present time varies, compared to the variation in the corresponding sales of electricity. The dotted line shows how the total monthly expenditure has varied during the different years, and the solid line the variation during these years of the monthly sales of electricity, the latter being taken for purposes of comparison at 6d. per unit. From this diagram it can be shown that the monthly costs only vary on the average about a quarter as much as the monthly sales do. Another point may be noticed in Diagram B. The crosses indicate the points representing the maximum call on the plant in the different years. One conclusion to be drawn from these curves is that the total monthly expenditure depends much more on the maximum rate at which the generating plant has to supply electricity during any year, than on the actual amount of electricity that has been supplied. This fact the author recognised in April, 1883, when, before meters were devised, he charged the consumers supplied by the old Hammond Company 6s. per arc lamp per week, and 1s. 6d. per carbon used; and after meters had been devised for the incandescent service, the charge was made at the rate of 1d. per lamp-hour if the lamps were not used three hours per day, and ½d. otherwise.

The present method of charging for electricity consumed adopted by the Brighton Corporation is an improvement on the above system, but still based on the same principles. In 1895 the charge for electricity consumed by anyone in Brighton is reduced to 3d. per unit as soon as the proper proportion of cost of having to be ready to supply that individual has been paid for by the revenue derived from his previous consumption in the same half-year being charged at 7d. per unit. This, in the year 1895, happens to be after the use of his greatest demand for one hour per day on the average. By means of this equitable tariff the Corporation are enabled to offer consumers who use





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their demand regularly four hours a day electricity at 4d. per unit, although coal costs the Corporation over 20s. a ton. All electricity consumed in Brighton, whether it be by private individuals or by the Corporation for street-lighting and other purposes, is charged on this basis.

The members will note from Diagram C and its accompanying table how rapidly the cost of supplying electricity diminishes in Brighton according to the length of time the demand is used per day, and they will probably agree with the author in thinking that for street-lighting (the demand being used in this case on the average nearly 11 hours per day, under which circumstances electricity can be supplied at 2d. per unit with a fair margin of profit), the time cannot be far distant when every street in the neighbourhood of the distributing mains will be electrically lighted, for there is no other suitable form of artificial illumination which can compete with electricity at this price.

From the repeated consideration of what items make up the total cost of supplying electricity, and recognising how small in stations of about the size of the present Brighton one the actual cost of running bears to the total cost of supply, the author is inclined to think that central-station engineers in the past have devoted too much of their time to the reduction of the running costs, and so have been compelled to neglect the important question of how to diminish the much greater standing costs involved in supplying electricity.

Now, with regard to the last feature of interest in the Brighton system—viz., the use in the residential districts of low-tension continuous current at light loads, and of high-tension alternating currents at periods of heavy load—the author thinks much credit ought to be given to Mr. Ward Leonard, an American electrical engineer, who pointed out in 1892 that the obvious corollary from the well-recognised fact of the low-tension system being most efficient at light loads and the high-tension system at heavy loads must be that some combination of the two ought to give the greatest efficiency; and it was clear that, providing the details could be satisfactorily worked out, as they have now been, it must necessarily be more economical and safer to run only the high-tension alternating system when the demand is heavy, and at all other times to supply the residential districts from the low-tension continuous-current system, than to continue to supply by means of alternating currents when the only reason for their use has ceased to exist — viz., big loads at big distances.

The map exhibited shows the distributing network, and where the combined system is used in the northern parts of Brighton. The circles represent the transformer-chambers, from which the low-tension distributing mains in the streets are supplied at times of high loads, and the circles with crosses the points where the connecting up to the low-tension distributing network takes place on the load becoming small. As meters are now procurable which will register equally accurately with alternating or continuous currents, there seems to the author to be no objection to this combined system; and when it is remembered how the periods of light load on the average last 10 times as long as the periods of heavy load, it must be clearly unnecessary to supply by means of the high-tension feeders and transformers those parts of the town which can be so much more economically supplied by low tension through the ordinary distributing main.

On concluding this somewhat lengthy paper, the author would like to state that the rapid development of the electric light at Brighton, besides being due to the long advertisement electricity has had here, must be greatly attributed to the splendidly liberal way in which the Brighton Corporation, through the Lighting Committee, have interpreted their duties as the business managers of the electricity undertaking—in supplying nearly every business street in the borough, and the principal residential districts, with electricity distributing mains; in recognising at an early date what a big undertaking and financial help to the town it might ultimately become; and the members, after visiting the works and seeing the extensions in progress there, will in all probability confirm these views.

WILL THE ELECTRIC MOTOR SUPERSEDE STEAM LOCOMOTIVES?

This is the title of an article by Mr. Joseph Wetzler which appears in the current issue of *Scribner*, and which on the page headings an intelligent proof reader has converted into "Will the Electric Motor supersede Steam?" which is quite another story.

Mr. Wetzler argues strongly in favour of the adoption of electric traction on railways, the conclusions derived from his arguments being as follows: (1) that the electric arts to-day are sufficiently advanced to supply the apparatus to operate successfully trains or single cars at speeds greater than have yet been attained by the steam locomotives; (2) that the operation of trains at such speeds is subject only to the considerations of economy, or, in other words, that people can travel at a speed perhaps up to 100 miles an hour and over, if they are willing to pay for it; (3) that the successful introduction of electricity on existing steam roads will probably require a change in the methods of handling passengers and freight, the single car on small or small train unit, operated at frequent intervals, taking the place of the present long train. In conclusion, the author states his firm belief that all railroads will be eventually operated electrically. The first changes from steam will probably be made on short suburban roads where the traffic is heavy and the trains are run at frequent intervals, and thus approximate more closely to the ideal conditions of the economical electric railway. These electric spurs will then be gradually extended until in the course of time the entire line will be adapted to the new order of affairs, and a new generation of railroad officers, less wedded to the older methods, will have come into existence. So far as new light railways are concerned, such as those contemplated in England at the present time, and which are rapidly increasing in the United States, electricity presents advantages which cannot be disputed. It has even been suggested that such agricultural roads might largely increase their income by supplying electric power for farming operations in the districts through which they pass. Some trolley roads in the United States do this now.

CITY AND GUILDS OF LONDON INSTITUTE TECHNOLOGICAL EXAMINATIONS, 1895.

ELECTRIC LIGHTING AND POWER DISTRIBUTION.

PRELIMINARY EXAMINATION.

Instructions.

No certificates will be given to candidates on the results of this preliminary examination, but their successes will be notified.

Candidates may take the ordinary grade without having passed the preliminary examination, or both examinations may be taken in the same year.

No candidate who has already passed in either grade of this subject can present himself for the preliminary examination.

The number of the question must be placed before the answer in the worked paper.

Not more than 10 questions to be answered.

Three hours allowed for this examination.

1. Give a diagram of the Post Office form of Wheatstone bridge, showing the connections.

2. Why are electric bells apt to work badly when coupled in series?

3. Where should fuses be placed in an electric lighting installation? And why?

4. A dynamo is 100 yards from a house, the conductor has a resistance of 0·002 ohm per yard, and there are 150 30-watt 100-volt lamps to be fed. What E.M.F. must the dynamo give?

5. Give a diagram with connections of a relay working an electric bell.

6. How would you test the insulation in a building you had wired?

7. What are transformers, and what are they for?

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8. How many 16-c.p. lamps, taking four watts per candle, can be run off a dynamo giving 7 e.h.p.

9. Why can a leaden bullet be fired further than a piece of wood of same shape and size?

10. If a man supports a weight of 10lb. for 17 minutes, does he do any work? If so, how much?

11. What are watt, pound, horse-power, volt, ampere, and ohm? Give any relations you can between them.

12. What is the three-wire system, and what is the good of it?

13. Two lamps of 100 and 150 ohms each, when running, are put in parallel with each other, and the pair is put in series with a lamp of 100 ohms. What E.M.F. will be needed on the system in order that it may consume 250 watts?

14. What is generally the difference between voltmeters and ampere-meters of the same type?

15. Why does an electromagnet pull so much less if you take out the iron core and replace it with a brass one?

16. Why are glow lamps generally run in parallel and arc lamps in series?

17. Define the terms: insulation, insulator, battery, switch, condenser, electromotive force, relay, depolariser, vacuum tube, electrode.

18. What is the white metal used for the tips of the contacts in electric bells? Why is silver not used for this purpose?

19. Sketch the arrangement of wires and switches that would enable a staircase lamp to be turned off or turned on from either the foot of the stairs or from the head of the stairs.

20. There is an electric bell at A and another at B, with a single line of wire between them. Show by sketches what arrangement of cells and switches are required that a person at either end can call up on the other bell without ringing that at his own end.

ALTERNATING AND INTERRUPTED ELECTRIC CURRENTS.*

BY PROF. GEORGE FORBES, M.A., F.R.S., M.I.C.E.

LECTURE II.

In my last lecture I indicated my desire during the course to illustrate a good deal the phenomena that occurred in using interrupted and alternating electric currents by means of mechanical analogies; and I think you will have already seen that, in certain cases at least, these mechanical analogies are of very great help to us in understanding what is going on. I propose to carry on the same method—through the present lecture at any rate. I concluded the last lecture by showing you by means of such mechanical analogies that we were able to form a clearer conception, as it seemed to me, of what is going on in a submarine cable than we would be able to without such mechanical analogy.

Now, I am very anxious to prevent anyone here from being led to draw too much from these mechanical analogies, and I warn you that they require a considerable amount of care in dealing with them. In going a step further, sometimes one is apt to miss the complete analogy, and so to be led to wrong deductions. This is not the case with the submarine cable which I showed you. In that case the analogy is, I may say, almost absolutely complete. There is only one defect in that analogy, and it is a trivial one—the resistance to the current is represented by the friction of the glycerine and water in this tall tube to the thread inside which is being twisted, and the current is represented by the velocity of rotation of that thread. Now, the force opposing the motion in the case of this glycerine varies as the square of the velocity. In the analogy the resistance ought to vary as the velocity. The opposing force varies as the square of the current instead of as the current, and that is the only defective part of the analogy; and it is really of very little consequence. As you all saw last day, it does not interfere with the very perfect representation of what is going on in a submarine cable. In fact, those who are accustomed to read the signals for a submarine cable agree that they cannot be distinguished from the signals given by this twisted thread. I said last lecture that these analogies would enable me to dispense with mathematical formulæ in explaining some obscure phenomena to you, but I would also wish to say that I think that these analogies are of more use really to the mathematician than to anybody else, because such analogies enable the mathematician to gain a clearer grasp of the quantities he is dealing with, and to treat them more easily than he would be able to do otherwise. In fact, I may say that Clerk Maxwell, in the whole of his great work on electricity, was merely working with mechanical analogies, although he does not say so in the book. It is obvious to anyone who reads that book that he was working out mechanical problems the whole time, knowing that the mechanical results at which he arrived would apply equally well to the electrical phenomena, and that instead of putting mass, momentum, and all those mechanical equivalents, he put the electrical equivalents. That is perfectly obvious, and if any proof of it was wanted it is in his invention of that word "electric displacement," which is a little puzzling to the electricians; but as soon as we realise that it is a mechanical equivalent the difficulty disappears.

Now, I was a little hurried last week at the end of my lecture in the demonstration of this apparatus, and it is such a very complete reproduction of what goes on in an Atlantic cable that I wish to make it a little more clear. At the top of this thread I have a spindle, with guides or bearings, wholly supported by a spring. On the spindle is a disc with vanes. There are also two brass jets, through either of which I can send a current of air to twist the thread in one direction or the other. These currents of air are manipulated from below. I may blow into the pipe, or I may use a reservoir of air, as I did on the last occasion, and the rotation is given to right or left by the two keys on the table, which open the air-valves and let the air pass in. The string itself is so chosen that it represents a long Atlantic cable. The way in which the measurements are made is this. To see that it represents a cable, you first, with a definite pressure of air, allow the string to rotate steadily round at a steady speed. Suppose it makes a revolution in a second. Then, with the same pressure, holding the bottom part of the string, or restraining it by means of magnets, apply the same air pressure and see how much twist it gives. It gives, perhaps, 10 revolutions. Divide that 10 revolutions by the one revolution, and that 10 gives you a constant of the cable; it gives you the ratio of the charge to the current, or the product of the capacity into the resistance; that defines the quality of the cable exactly, and the number of turns that the top of the string can give defines the capacity of the cable as a condenser. I will not delay you further to explain the ways in which this is an extremely close analogy, because it will become tedious. Those of you who have followed me so far, and have any interest in submarine cables, will see the very close analogy which there is.

I have placed upon a table here a number of electrical measurements which can be taken, and their analogies. I have simply put them up there as a means of reference. I have given examples of certain units which may be assumed; for instance, volt and ampere. From these all the other units will follow. I have assumed one volt to mean 1oz. driving at a radius of 1in., and one ampere one revolution per second. A coulomb is equivalent to one revolution; there is a farad when it makes one revolution with 1oz. of pressure; a henry, if you have a current of one ampere gradually reduced during one second of time by its own self-induction to zero. The pressure that is in that interval of time being constantly exerted is the equivalent of one volt—and that is obtained by the momentum of a cylinder of 1in. radius weighing 62oz. That is all I need say about that at the present time. Of course, these units might be varied, and when we are dealing with submarine cables we will take very different ones from these. On the other hand, we might take, for instance, an ampere to be 300 revolutions per second. So, when we are dealing with transmission of power from one place to another, if we wanted to make an analogy we would use other units from these. In each particular case we select our own units.

The primary discovery in electromagnetics was made by Oersted in 1820, when he showed that an electric current would deflect a magnet. From that simple experiment the philosopher might have retired to his chamber and worked out the whole of the electromagnetic phenomena which we are at present acquainted with. He could have seen that the north pole tends to rotate round the wire carrying a current in one direction and the south in another. He would have foreseen Faraday's experiment, in which a pole was made to rotate; he would have seen that in producing this mechanical action some power was used, and therefore the current was diminished and a counter E.M.F. set up in the wires; he would have seen that a wire acted as a magnet, and would consequently, when properly wound round a core, induce magnetism in a piece of soft iron.

But of all these different phenomena, the one I wish to direct your attention to most to-day is the work of Faraday. I have got to show it in its crudest and most simple and elementary form. I have here (Fig. 14) a single wire, which I shall connect with a battery through which I can suddenly send an electric current. In its neighbourhood, but not touching it, I have another wire which is not connected with any battery, but is connected with the galvanometer at the far end of the room. What I wish to show you is that at the moment of making an electrical contact

* Lecture delivered before the Royal Institution.

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with the one wire, a current in the opposite direction is generated in the second one, and on breaking it a current in the same direction as the primary current is created ; that is to say, we ought to get a deflection of the galvanometer connected with the wire in one direction when we make the circuit, and in the other direction when we break it. Remember the galvanometer shows a current generated in the wire which has no battery connected with it.

Now, this phenomenon of induction is somewhat equivalent to momentum ; it may be considered as the equivalent of momentum. It sets up a counter E.M.F. in the wire through which the electric current is sent. It is just like the effect produced when we set a mass in motion—there is at first an opposition to its motion, and that is due to its momentum, and is a good analogue of the induced current.

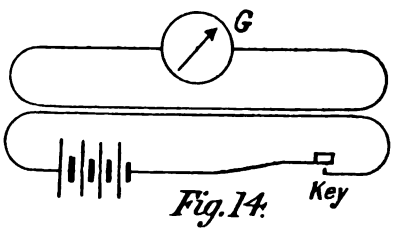

Fig. 14.

Now, you will see we have a spot of light upon the screen perfectly steady. I will send a positive current in one direction through one wire, and the spot of light, which indicates the current which goes through the other wire, is deflected to the right. I will now break the current, and the spot of light goes in the opposite direction, showing the current is induced in the opposite direction when we break the circuit. Now, a certain amount of power is being generated in the second wire, which is, of course, being taken out of the primary wire, through which the current is going—that is to say, momentarily the E.M.F. is acting against the current in the primary wire. That I have said is analogous to momentum. For example, here (Fig. 19) I have a rod with a heavy flywheel at the base of it. If I try to give a rotation to it with my finger there is at first an opposition to the motion—there is a sensible opposition, and it takes some little time to acquire the steady rotary motion which it eventually obtains. That resistance which my finger experiences is the counter E.M.F. But once I have started the thing, and it has acquired a steady rotation, there is no such counter E.M.F. acting at all. If I try to stop it I feel the effect of the flywheel trying to pull my finger round, and trying to continue its motion in the same direction. That gives us a clear idea of the self-induction that is taking place.

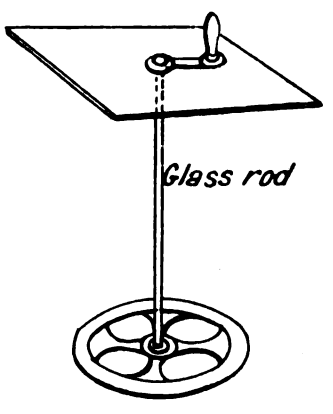

Fig. 19.

The application of these experiments and phenomena really belongs to great engineering works. In these we have frequently to do with alternating currents instead of continuous, and you will be able to see by the analogy that we have the induction of thecurrent producing a very remarkable difference in its effects in the two cases. After I have once got the flywheel started by applying a very slight force at the top, the flywheel has nothing to do with the rotation. But now suppose I try to produce an alternating current with the same force backwards and forwards. I find that I am not able to get up the same velocity, that the momentum of the flywheel interferes most materially with the freedom of rotation, and I am not able to get the same speed or the same current through my circuit by that means as I did with the continuous current. That that is the case I am going to show you very simply by means of a lamp, which is a very good indicator of the strength of a current. I have here a coil of wire, which is really a Gramme ring, and I will pass a current of electricity through this coil of wire and then through the lamp, Fig. 15. First, I will use a continuous current, and show you that the lamp at once acquires its full brightness. I will then use an alternating current, and show that the behaviour is very different, because here in the self-induction of this coil we have the momentum of the current acting in the same way as the momentum of the flywheel that I showed you. We will now try a continuous current. Now the current is simply passing through the resistance and through the lamp, and being a continuous current, there is no self-induction and no counter E.M.F. generated. Consequently, when I short-circuit the coil you see no perceptible diminution in the light of the lamp. The resistance of that coil, then, is very slight indeed, and produces no effect. I will now put on an alternating current. I cut out the self-induction coil, and I have now the alternating current passing through the lamp directly, and you see it gives the same brightness as with the continuous current—using 100 volts as I did before. I will now cut out this short-circuit and allow the current not only to pass through the lamp, but also to pass through the self-induction coil acting as the flywheel to which we are trying to give oscillating movements, and the lamp is immediately greatly diminished in brilliancy, as the effect of the reduction in the current produced by the coil.

Now, one of the greatest helps given to electrical engineering by the discoveries of Faraday has been the invention of the induction coil, or, as it is sometimes now called, the transformer. This can only be used with alternating currents. I have a specimen of a transformer on the table here. It consists of a core, of a bundle of iron wires, through the centre, with a coil of wire wound round it ; around that again there is a separate coil of wire, and presently I shall show you that when we change the strength of the current in the one wire a current is generated in the other wire. In fact, the transformer gives really a magnified effect of the induction of two wires upon each other. That

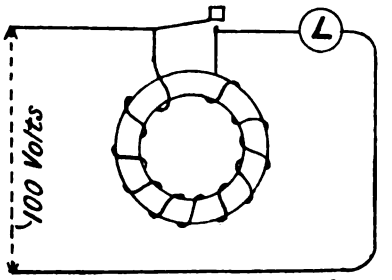

Fig. 15.

we were only able to detect by means of the galvanometer. The action of the transformer is much more powerful. The iron core is introduced, and instead of having a single wire, a number of coils are wound round, and that increases the effect to a great extent. The transformer has been of much use to electric light engineers in the past, because it enables us to convert a current of one pressure into a current of another pressure. If we have a large number of turns of wire on one of these coils, and a small number on the other, we may convert a high-pressure current into a low-pressure current, or *vice versâ*. That has been of great use in electric light engineering, enabling us to carry a high-pressure current to great distances over a thin wire, and to transform it at the point of consumption, where the consumers of electric light were pleased to transform the current to one of low pressure, such as is suitable for electric lamps and perfectly safe to handle.

But if that has been of use in electric light engineering, it has been infinitely more useful in electromotive power distribution. When I first had to investigate the problem of transmitting power from a power station at the Niagara Falls to different consumers who might be near at hand or far away, the first thing that struck me was the enormous difference in the character of the electric currents that different people wanted. Some people wanted it for lighting, some wanted it for power, some wanted it to generate electric currents for electrolytic operations ; some wanted continuous currents and some wanted alternating ; some wanted 100 volts and some 50 volts. I do not say that it would have been impossible to have supplied these demands by means of a continuous current, but there would have been very great difficulty in doing so, and in every single case it would have been necessary to introduce a motor driving a dynamo. The expense and the trouble of such a distribution would have been simply enormous. And although some very high authorities—I may mention Lord Kelvin among others, he almost alone now—persistently said that the continuous current would have been the best for the purpose, I am glad to say that in that great work the alternating current has been used, and it is a matter for congratulation to everybody concerned that the further we proceed with the work the more we see its adaptability to all the different circumstances that arise.

Now, with regard to this mutual induction which takes place in the transformer, I am going to show you the effect in a more striking way than by using the alternating current. I am going to show you that with the continuous current when you break the one circuit you are able to get a very powerful E.M.F. in

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the other circuit. I shall pass a continuous current at 100 volts through the fine coil of this transformer, Fig. 16 ; I shall then break the circuit suddenly, and you will be able to see that, at the moment of breaking, an induced current is created in the secondary coil which will be sufficient to light up the lamp in circuit with it. I will first show you this without producing any effect—that is, with the electromagnet unexcited. I have now closed the primary circuit, and when I break the circuit it will not be sufficient to light the lamp. The counter E.M.F. is not sufficient to light that lamp, although I break this circuit as sharply as possible. The reason is that an arc is formed, as you perceive, where I break the circuit. This putting in of a graduated resistance which prevents a sudden break to the circuit causes the break in the circuit to be gradual and slow, whereas it is the suddenness of the break that causes the illumination of the lamp.

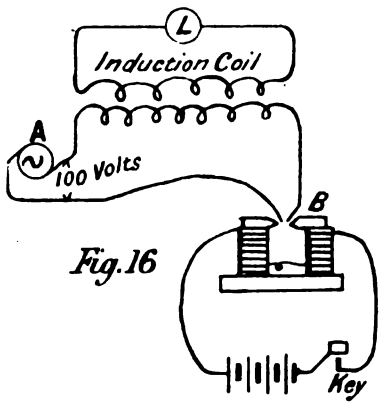

Fig. 16

I will now excite the electromagnet, and you will see that when I break the circuit at a point between the poles of the electromagnet, the electromagnet will not allow an arc of light to remain. The tendency is for the current of electricity to be deflected. That arc of light is the current of electricity, and the arc will be blown out almost instantaneously, and this enables me to get a sudden break instead of the gradual break which I had before. Now I have made the contact, and as soon as I break it you will notice that a much sharper spark is produced than before, that the lamp now lights up brilliantly ; and by having a very powerful magnet it is possible to produce a very sudden break indeed, and consequently a high E.M.F. in the secondary circuit.

(To be continued.)

THE SELECT COMMITTEE ON TELEPHONY.

The Committee of the House of Commons which is considering the sufficiency of the telephone service sat again on Friday last, Mr. A. Morley presiding.

The first witness taken was **Mr. Provand, M.P.**, who complained of the increase which he contended would be made in the trunk wire rates by the Post Office under the arrangement entered into with the National Telephone Company. In many cases the charge made by the Post Office was twice as much as that made by the company. Telephone users would be in a worse position under the new arrangements than they were at present, as the trunk wire rates that would be charged by the Post Office were higher than the rates now charged by the company. He further contended that the public interest had not been properly safeguarded under the agreement with the telephone company, and that it handed over to the company privileges which they ought not to possess. A charge for terminals was, in his opinion, altogether unjustifiable, and would be found to be very oppressive.

Mr. W. H. Preece, chief electrician to the Post Office, subsequently gave evidence explaining in detail the construction and the working of the telephone and the improvements that have been made of late years.

The committee then adjourned until Tuesday, when **Mr. Preece**, continuing his evidence on behalf of the Department, spoke in the highest terms of the automatic signals in operation in the United States in connection with the exchanges, which had a great advantage in preventing the confusion which the lack of these signals caused in this country.

Sir James Ferguson asked witness a question implying that it was impossible to adopt a similar system here.

Mr. Preece said the word "impossible" did not exist in his vocabulary. Mr. Preece proceeded to give his reasons against the municipalisation of the telephones. He explained that he thought it inexpedient that a town council should have control of a growing, speculative, and competitive industry like the telephones, which could only be maintained in a state of high efficiency when the service pays. An active opposition on the part of the National Telephone Company, who were not dependent for their success upon one local centre, could easily prevent a local success on the part of the town council. Again, financial failure and a constant call upon the rates would speedily raise the opposition of the class of ratepayers who did not use the telephone, and who were the masters of the situation. Further, high efficiency depended upon skilled labour and efficient supervision, and small local bodies could not afford to pay the high salaries that would command efficiency. In small municipalities not managed by skilled men the service must be defective.

After some further evidence, the committee adjourned.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

Returns have been made to the House of Commons stating the nature of the proposals contained in the Electric Lighting Provisional Orders (No. 1) Bill, (No. 2) Bill, and (No. 3) Bill.

MOTHERWELL ELECTRIC LIGHTING ORDER, 1895.—The undertakers under this order are the Commissioners of the burgh of Motherwell. The area of supply is the burgh of Motherwell. The order contains provisions that the Commissioners shall lay down mains in certain specified streets within a period of two years, and it provides for the supply of electrical energy in the remainder of the area on certain specified conditions. The order also contains provisions (1) for the approval by the Board of Trade of the system upon which energy is to be supplied, and the issue by them of regulations for securing the safety of the public, and for ensuring a proper and sufficient supply of energy ; (2) for the execution of the necessary works and the breaking up of streets, etc., and the alteration of pipes, etc., under streets ; (3) for regulating the manner in which energy is to be charged for, and fixing the maximum price to be charged ; (4) for the appointment, remuneration, and duties of electric inspectors, and the testing of electric lines and other works, and for holding enquiries by the Board of Trade as to the causes of accidents affecting the public safety ; (5) for the supply, use, certifying, inspection, etc., of meters ; (6) for the application of moneys received by the undertakers in respect of the undertaking ; (7) for the transfer to any company or person of the powers, duties, and liabilities of the Commissioners under the order by means of a deed to be approved by the Board of Trade, upon such terms and subject to such exceptions and modification (if any), and for such period as may be specified therein ; (8) for the revocation of the order under certain circumstances.

STIRLING ELECTRIC LIGHTING ORDER, 1895.—The undertakers are the Commissioners of the burgh of Stirling. The area of supply is the parliamentary burgh of Stirling. The order contains provisions similar to those referred to in the case of the previous order.

ALDERLEY EDGE LIGHTING ORDER, 1895.—The undertakers under this order are the District Council of Alderley Edge. The area of supply is the urban district of Alderley Edge. The order contains provisions similar to those above.

LEIGH ELECTRIC LIGHTING ORDER, 1895.—The undertakers are the District Council of Leigh. The area of supply is the urban district of Leigh. The order contains provisions similar to those above.

LLANDUDNO ELECTRIC LIGHTING ORDER, 1895.—The undertakers are the District Council of Llandudno. The area of supply is the urban district of Llandudno. The order contains similar provisions to those above.

LUTON CORPORATION ELECTRIC LIGHTING ORDER, 1895.—The undertakers are the Corporation of Luton. The area of supply is the borough of Luton. The order contains similar provisions to those above.

RADCLIFFE ELECTRIC LIGHTING ORDER, 1895.—The undertakers are the District Council of Radcliffe. The area of supply is the urban district of Radcliffe. The order contains similar provisions to those above.

SWINDON NEW TOWN ELECTRIC LIGHTING ORDER, 1895.—The undertakers are the District Council of Swindon New Town. The area of supply is the urban district of Swindon New Town. The order contains similar provisions to those above.

CARLISLE CORPORATION ELECTRIC LIGHTING ORDER, 1895.—The undertakers under this order are the Corporation of Carlisle. The area of supply is the city and municipal borough of Carlisle. Similar provisions are contained as in the foregoing.

PONTYPOOL ELECTRIC LIGHTING ORDER, 1895.—The undertakers are the Pontypool Electric Light and Power Company, Limited. The area of supply is the urban district of Pontypool. The order also provides for the revocation of the Pontypool Electric Lighting License, 1893.

WALTHAMSTOW ELECTRIC LIGHTING ORDER, 1895.—The undertakers are the District Council of Walthamstow. The area of supply is the urban district of Walthamstow.

WINCHESTER ELECTRIC LIGHTING ORDER, 1895.—The undertakers are the Corporation of Winchester. The area of supply is the city of Winchester.

WORTHING ELECTRIC LIGHTING ORDER, 1895.—The undertakers are the Corporation of Worthing. The area of supply is the borough of Worthing.

LEGAL INTELLIGENCE.

PROELL GEAR.

On Wednesday there came before the Judicial Committee of the Privy Council (present — Lord Watson, Lord Hobhouse,

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Lord Morris, Lord Davey, and Sir Richard Couch) the case of Carl Pieper's patent. It was a petition for the prolongation of letters patent granted to Carl Pieper, civil engineer and patent agent, Berlin, for an invention of "certain improvements in the expansion gear of steam-engines," a communication from Dr. Wilhelm Rudolph Proell, of Dresden, bearing date May 12, 1881, and numbered 2,069.

Mr. A. J. Walter and Mr. Fearnley Owen were counsel for the petitioners; the Attorney-General and Mr. Sutton for the Crown.

The invention for which the letters patent were granted consisted in an improved liberating expansion gear—namely, a mechanism in which the parts of an engine serving to transmit motion from the eccentric to the admission or expansion valve were disengaged from each other in a novel manner at a certain point of each stroke under the control of the governor. It was stated that the chief merit of the invention lay in the fact that automatic variable expansion could by its application be secured with the fewest possible parts, which admitted of a very compact construction, and the use of the invention had rendered it possible to apply the principle of automatic variable expansion to existing steam-engines without the necessity of removing the cylinder of the engine and replacing it with a new one, as would have been formerly necessary. The invention could not only be applied to slide valves but also to double-beat valves; and for the purposes of obtaining the full advantage of the system of automatic variable expansion double-beat valves were to be preferred. Dr. Proell in 1881 also obtained grants of letters patent for his invention in Germany, Austria-Hungary, and France, all of which foreign patents had now expired. In 1883 Dr. Proell appointed Dr. Hermann Kühne his agent in this country for the purpose of pushing the invention here, upon the terms that Dr. Kühne should receive one-half of the royalties received from the use of the invention. In 1886 the letters patent were by direction of Dr. Proell assigned to Dr. Khüne, the equitable estate in them being vested in Dr. Proell. On September 4, 1892, Dr. Proell died, and the equitable estate in the letters patent since that date had been and was now vested in his widow, the legal estate in them being vested in Dr. Khüne. Owing, it was stated, to the great indifference which the invention met with in this country at its first introduction, the gross receipts during the earlier years were wholly inadequate. The great utility of the invention was now being generally recognised, and it was only now, when the letters patent were about to expire, that the use of the invention was becoming fully established and extending. The petitioners had no doubt that if the term of the letters patent should be extended the letters patent would become productive, and the petitioners would be able to obtain a fair reimbursement and remuneration commensurate with the public value and importance of the invention. The gross amount of the royalties received in England in respect of the invention was £7,986.

The **Attorney-General**, on the part of the Crown, admitted that the invention was one of merit.

Mr. Sutton said the Crown desired to leave the matter in their Lordships' hands. He addressed their Lordships on the question of the amount of remuneration received.

A number of witnesses was called in support of the petition, and gave evidence testifying to the merit of the invention, one of the advantages arising from the use of which was the great reduction which it effected in the consumption of fuel.

Lord Watson, in delivering their Lordships' judgment, said that in this case their Lordships were invited to grant an order for which, as far as they were aware, there was no precedent—and none had been stated by counsel at the Bar. The patent sought to be prolonged was one of four—three of which were issued in continental countries, the last of which expired two years ago, since which date the patent in question had still been current, and her Majesty's subjects exposed to some degree of prejudice which was not occasioned to the inhabitants of any other country. Their Lordships were not prepared to say that in these circumstances there could be no renewal of the patent, but they were certainly prepared to go this length, that the circumstance of its being the last patent—the sole survivor—was in these circumstances a great obstacle to granting a renewal. It would require very strong grounds to warrant the renewal of the patent in these circumstances, and their Lordships had not been able to find any grounds to warrant them in doing so, although they were quite prepared to hold that the patent had sufficient merit to warrant a prolongation in favourable circumstances. Their Lordships refused the application.—*The Times*.

IN RE THE MERSEY RAILWAY COMPANY.

An application has been made in the High Court of Justice by the receivers and managers for leave to spend a sum of about £800 in promoting a Bill in Parliament with the object of conferring upon the company power to work their railway by electricity in lieu of steam. The summons was heard in chambers, but his Lordship gave judgment this morning in court.

Mr. Butcher appeared for the applicants; Mr. Theobald for the first debenture stock holders supported, and Mr. E. Ford for the second debenture stock holders opposed the summons. Mr. R. J. Norton represented the company.

Mr. Justice Stirling said that the question was whether the money in the hands of the receivers could be thus applied under Section 4 of the Railway Companies Act, 1867. It did not appear to come within "working expenses" of the railway or other proper outgoings in respect of the undertaking. It was an application to Parliament to vary the mode of carrying on the business of the company. Neither was it in the nature of salvage. If all the parties had been agreed, his Lordship might have been inclined to accede to the application. It seemed probable that it might help the business of the company, but it was a speculation, and his Lordship could not allow any part of the fund in court to be applied for that purpose.

COMPANIES' MEETINGS AND REPORTS.

SUBMARINE CABLES TRUST.

On Friday last Sir John Pender, M.P., presided at the twenty-fourth annual meeting of certificate-holders of the Submarine Cables Trust, held in the Board-room at Winchester House.

The **Chairman**, in moving the adoption of the report, said the revenue for the past year amounted to £21,464, as against £22,592 for the previous year, or a decrease of £1,128. This was owing to their having received a smaller dividend for the current year in the Anglo-American Company. The expenses of the Trust for the year amounted to £1,194, as against £1,501 for last year. The total expenses, however, were £805 less than the amount provided by the trust deed. The revenue for the year had enabled them to meet two coupons of £3; but they had not been able to pay anything off the remaining portion of the overdue coupons. There was, therefore, still a balance of £15 in arrear, but this, they anticipated, would be paid about the middle of July next. The present market value of the investments held by the Trust over cost price showed an increase of over 52 per cent.

Mr. Kenneth L. M. Anderson seconded, and the motion was carried.

The **Chairman** remarked that while telegraphs flourished the Trust would continue to flourish.

MORECAMBE ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

The fourth annual meeting of shareholders has been held at Morecambe, the proceedings being conducted in private. Mr. C. M. Mabbott, chairman of the Company, presided.

The report showed a loss of £424. 14s. 5d., mainly due to loss on supply of current consequent on the "scale system" of annual charges per lamp being found unremunerative. This had been a serious mistake, and would be abandoned forthwith in favour of supply by meter. Law costs and fine for nuisance accounted for £48. 12s. 8d. The conviction for nuisance had necessitated the removal of the premises to a non-residential part of the town, and for this it was proposed to raise £1,800 of preferential capital. The report and balance-sheet were adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Birkenhead.—The Corporation invite tenders by 23rd inst. for boilers, engines, dynamos, etc. Particulars are given in our advertisement columns.

Edinburgh.—Contractors willing to do electric wiring and fitting to specification in Edinburgh are requested to communicate with Prof. George Forbes, 34, Great George-street, Westminster.

London, E.C.—Among stores for which the Great Eastern Railway Company invite tenders by May 16 are (17) telegraph materials, and (19) leather and indiarubber. Forms of tender can be obtained at the secretary's office, Liverpool-street Terminus, E.C.

Burton-on-Trent.—Tenders are invited for the supply of 25,000 tons, or a portion thereof, of best screened gas coal, for the Town Council. Forms of tender and conditions of supply may be obtained upon application to Mr. F. L. Ramsden, manager and engineer, Gas and Electric Light Works, Wetmore road, Burton-upon-Trent, and sealed tenders, endorsed "Coal," are to be delivered to the manager at or before 10 a.m. on 25th inst.

Tunbridge Wells.—Tenders are invited by the Corporation for the wiring of the Municipal Buildings in accordance with the specification prepared by the electrical engineer. Copies of the specification may be obtained from Mr. W. C. Cripps, town clerk, Town Hall, Tunbridge Wells, on payment of a deposit of £1, which sum will be returned on receipt of a bona fide tender. The buildings can be inspected at any time. Tenders, endorsed "Electric Light," must be sent to the town clerk by 28th inst.

Brighton.—Notice is given that the Council of the borough will receive tenders from such persons as may be willing to enter into a contract for the supply and erection of boilers at the Corporation electricity works. The Council also want tenders for the supply and erection of arc lamps, switches, etc., and, thirdly, for the supply of indiarubber lead-covered armoured cables. Specifications can be obtained on application at the town clerk's office, Town Hall, Brighton. Tenders for the boilers are to be sent in by May 13; for the arc lamps, switches, etc., by May 27; and for the indiarubber lead-covered armoured cables by May 13.

Rangoon.—Tenders will be received by the president of the Rangoon Municipal Committee, not later than November 4, for the lighting of Rangoon by electricity. Tenders should be accompanied by detailed plans, specifications, and estimates, and must state the terms on which the installation proposed will be under-

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taken. All information regarding the existing system of lighting and the cost, etc., with plan of the town, can be obtained on application to Messrs. Ogilvy, Gillanders, and Co., Sun-court, 67, Cornhill, London, E.C., accompanied by a remittance of £1. 1s. Tenders are to be sent in sealed covers and endorsed "Tender for Electric Lighting, Rangoon." Mr. J. Short, Rangoon, is the secretary of the committee.

Manchester.—The Corporation invite tenders for the supply, delivery, and erection, complete, of the electric lighting machinery and installation for the efficient lighting of the new foreign animals wharf, situated at Mode Wheel. Copies of general conditions, specification, and drawing can be obtained on application to Mr. T. de Courcy Meade, city surveyor, Town Hall, Manchester, on payment of five guineas (which will be returned on receipt of a *bonâ fide* tender). Tenders, to be endorsed "Tender for Electric Lighting, etc., Foreign Animals Wharf, Mode Wheel," to be addressed to the chairman of the Markets Committee, and delivered at the city surveyor's office not later than 9 a.m. on Monday, May 13 The Corporation do not bind themselves to accept the lowest or any tender.

Shoreditch.—The Vestry invite tenders for the erection of a dust destructor, 12 furnaces, flues, boilers, and accessories, to be guaranteed capable of dealing with about 20,000 tons of refuse per annum and of producing the amount of steam stated in the specification for electric lighting and other purposes. A formal contract to be entered into under seal, with sufficient sureties, to secure such guarantee. Forms of specification and sketch plan, with further information, may be obtained from Messrs. Kincaid, Waller, and Manville, the engineers, of 29, Great George-street, Westminster, S.W., on payment of £3. 3s., which will be returned to persons tendering on a bona fide tender being received by the Vestry. Sealed tenders must be sent to the vestry clerk, endorsed "Tender for Dust Destructor, etc.," by Monday, May 20, or by such extended period as may be specially allowed to any intending contractors upon application to the engineers; and contractors, or their representatives, must attend at the Town Hall, Old-street, E.C., at 6 p.m. on the same date, when the tenders will be considered by the committee. Trade union rates of wages and hours must be observed by contractors.

BUSINESS NOTES.

Derby.—The electric lighting of the market hall has been completed.

Great Northern Telegraph Company.—For the month of April the receipts were £27,600.

Burton-on-Trent.—There was a loss last year on the Corporation electric light station of £1,800.

Blackburn.—The cost of all the electric lamp-posts which have been erected in the town is £240. 16s.

Fairfield (Buxton).—The Urban District Council have appointed an Electric Lighting Committee.

Tottenham.—The District Council have referred the question of electric lighting to the General Purposes Committee.

Direct Spanish Telegraph Company.—For the month of April the receipts were £1,942, as against £1,742 for the same period of 1894.

Eastern Telegraph Company.—The receipts for the month of April were £67,046, as against £56,751 for the corresponding period of 1894.

South London.—The Board of Trade announce that the Battersea and Newington provisional electric lighting orders will not be proceeded with.

West India and Panama Telegraph Company.—The receipts for the two weeks ended April 30 were £106 more than for the corresponding period of 1894.

Eastern Extension Telegraph Company.—For the month of April the receipts show a decrease of £722 as compared with the corresponding period of 1894.

South Staffordshire Trams.—The Board of Trade have granted a further extension of the license for the use of steam on the South Staffordshire tramways until May 15.

Aden.—The sum of Rs.20,500 has been provided in the current estimates for the maintenance of electrical communications in connection with the defence works at Aden.

London Platino-Brazilian Telegraph Company.—The ordinary general meeting was held on Monday at Blomfield House, London-wall. The proceedings were not open to the Press.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 5th inst. amounted to £1,148, as compared with £874 in the corresponding week of last year.

Eccles.—The engineer of the sewage farm works has reported to the Town Council that the contractors for the electric light installation have commenced the wiring of the manager's house.

Madras.—The consulting engineer to the Indian Government for railways has reported that there is no impediment to the Madras electric tramway being opened for public traffic, and that no danger will attend its use.

Stourport.—A meeting of the Urban District Council has been held at which, on the motion of the chairman (Mr. C. K. Harrison) seconded by Mr. Beakbane, the Council approved of the proposal to connect Kidderminster with Stourport by the suggested electric tramway.

Wimbledon.—At the last meeting of the District Council the Road and Drainage Committee reported that the question of electric lighting had been fully discussed, and that Mr. W. H. Preece had (as we have already announced) been instructed to make a report.

Cardiff.—The Lighting Committee of the Town Council have recommended the borrowing of £1,860 for the extension of the electric light mains to Guildford-street baths and down Newport-road as far as Castle-road and up West-grove. The Corporation will consider the matter.

Kendal.—The Town Council have held a meeting at which a resolution passed by the Chamber of Commerce was read, asking the Council to consider the question of supplying the town with electricity for power purposes, and it was agreed to reply that the matter was engaging the attention of the Corporation.

City and South London Railway.—The receipts of the Company for the week ended May 5 were £864, against £887 for the corresponding week of 1894, or a decrease of £23. The total receipts for the current period of the present half-year are £16,983 against £16,401 in the corresponding period of 1894, an increase of £582

Cowes.—A meeting of the District Council has been held, at which the Water and Lighting Committee's minutes stated that the surveyor having reported on the result of the canvass *re* electric lighting, they had decided to recommend the Council to obtain the opinion of an expert on the plans of the surveyor as to this mode of lighting as early as possible. This proposal was approved of by the Council.

St. Pancras.—The Vestry have agreed to lay an electric main from University-street, along Gower-street, to the parish boundary at a cost of about £214. The Electrical Committee have been instructed to consider the question of extending the mains along Highgate-road and West-hill. The tender of Mr. James Steed, of 61, Chalk Farm-road, for £415. 8s. 5d., for building the sub-station in St. Andrew's-gardens, has been accepted.

Burnley.—Alderman Collinge said at a meeting of the Town Council that the Gas and Electric Lighting Committee had, on the recommendation of Mr. Thursfield, resolved that the engine driver and fireman of the electric lighting works should be allowed a week's holiday in the summer and have their wages paid. Both of these men were fully occupied the year round, Sundays included, and got no holiday whatever. The minutes were passed.

Liverpool.—The usual weekly meeting of the Lighting Committee of the Corporation was held on Monday at the municipal offices, Alderman F. Smith presiding. There was no further consideration of the proposed purchase by the Corporation of the Electric Supply Company's undertaking, it being understood that the report was being awaited of Sir Frederick Bramwell in regard to the business carried on by the electric supply company.

Electric Cooking Apparatus.—Messrs. Crompton and Co., Limited, send us from their Brompton-road branch an illustrated price-list of electrical heating and cooking apparatus. The list includes ovens, hot-plates, kettles, frypans, saucepans, urns, sealing-wax heaters, cigar lighters, irons (flat and otherwise) and radiators. An interesting pamphlet on cooking by electricity has also been issued by Mr. H. J. Dowsing, of Messrs. Crompton and Co.'s firm.

Cupar (Fife).—At a meeting of the Fife County Road Board in Cupar, Mr. Haig, of Ramornie, submitted the sub-committee's report on telephones, and it was agreed to give powers to the committee to make a fair and reasonable agreement with the telephone company on the basis of getting 2s. 6d. per mile of wire for wayleave, and as much accommodation as possible from the company in the way of free telephone instruments at several of the police offices in the county.

Fulham.—The Vestry have held a meeting, at which Mr. W. R. Sayer proposed that a special committee of 15 should be appointed to consider and report as to the advisability of applying for a provisional order to supply the electric light to the parish, also as to constructing a destructor in connection therewith. This was carried. The Lighting Committee have also appointed a special sub-committee to consider the question of lighting the Town Hall by electricity and the cost thereof.

Grantham.—The Estates Committee have reported to the Town Council that, after considering an application made by Messrs. Martin and Fitt, of High-street, asking to be allowed to carry light cables across the streets of the borough for the supply of electric light, they did not see their way clear to recommend the Council to grant to Messrs. Martin and Fitt a general license for the above purpose, but they were prepared to deal with each separate application on its merits.

Dover.—The Dover Council have met, when, in reply to Councillor Fry, who said the lamps were lighted at 7.40, the Town Clerk stated that every light ought to be turned on at sunset. The town clerk was ordered to write to the company calling their attention to this fact, and the police were ordered to include the lights in their nightly reports on the lighting. A letter was also read from the Board of Trade stating that they were unable to send one of their inspectors to inspect the works.

Electric Lighting Extension in London.—The Board of Trade have decided to grant a provisional order to the County of London and Brush Provincial Electric Lighting Company, Limited, for power to supply electricity within the district of the St. Olave's Board of Works. The Board have also granted a provisional order to the Charing Cross and Strand Electricity Supply Corporation, Limited, for the electric lighting of the district within the jurisdiction of the Strand District Board of Works.

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Chiswick.—The clerk to the District Council at the last meeting of that body read a letter from Mr. Watts, of Devonhurst, Duke's-avenue, asking when the electric lighting scheme for Chiswick was likely to be completed, as he was having certain alterations made to his house, and desired to have electric light fittings fixed. The Clerk intimated that he had replied to the effect that it was hoped that the electric light would very shortly be available. The Surveyor said the company hoped to have the mains laid in a month.

Cheltenham.—According to the minutes of the Electric Lighting Committee of the Town Council, Mr. Preece has expressed his willingness to come to Cheltenham to take part in the inauguration of the lighting by the Corporation on Thursday next. It was resolved that Prof. Ayrton, F.R.S., Mr. A. Siemens, and Mr. Callender be invited to the opening. Baron de Ferrieres wrote suggesting that an arc lamp on a tall post should be placed at the junction of the Colonnade and High-street, and it was resolved to adjourn the matter for further consideration.

Electric Launch.—An experimental test of the recently invented Clydebank electric primary battery took place this week on the Clyde at Glasgow, says the *Scotsman*. Four sets of batteries were placed in a small boat 16ft. long, and these were connected with a small motor fixed in the centre of the little vessel. The batteries weighed over 1cwt., and each cell—there being 12 cells in a battery—measured 8in. by 3in. by 3in. The boat went at the rate of about six miles an hour. Messrs. R. and A. Macdonald, Clydebank, are the inventors.

City and South London Railway Bill.—Lord Morley's Committee of the House of Lords on Monday passed the Bill which grants to the City and South London Railway Company an extension of time for three years within which to construct the authorised extension of their electric railway from Stockwell to Clapham Common. The Bill also empowers the company to raise £30,000 additional ordinary or preference capital. and to borrow a further sum of £10,000 by the creation of debenture stock. This Bill has now been sanctioned by both Houses.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,891. The directors of the Company, subject to final audit, have decided, after placing £8,000 to the reserve fund and £5,000 to the debenture redemption fund, to recommend the payment of 6s. per share, free of income tax, making, with the interim dividend paid in November, a total distribution of £3 per cent. for the 12 months ending December 31. This will give 6s. to the ordinary, 4s. 6d. to the preferred ordinary, and 1s. 6d. to the deferred ordinary shareholders.

Belfast.—The report of the Electric Committee of the Corporation presented at the last meeting of the latter body contained the following: "With a view to encourage the 'daylight' consumption of electric current, your committee have fixed the charge for electricity used for heating, motor, and purposes other than lighting during the daytime at 4d. per unit, with discounts, and if this be taken advantage of to any appreciable extent it may lead to a reduction in the charge made for lighting purposes." On the motion of Alderman Pirrie, seconded by Alderman Lawther, the report was adopted.

Gold Medal.—Messrs Crompton and Co., Limited, have just been awarded a diploma and gold medal at the Universal Food and Cookery Exhibition now being held at the Portman Rooms. This is the fifth diploma and fourth gold medal obtained by Messrs. Crompton and Co. since they started the manufacture of electrical heating and cooking apparatus about two years ago. The awards in each case have been made by experts in the particular business concerned, and the samples of food being cooked daily in the electric oven are pronounced by those most competent to give an opinion to be the "perfection of cookery."

Worcester.—Mr. Ruthven Murray having been appointed to take charge of the electricity works, the Streets and Water Committees of the Town Council recommend that Mr. Caink be relieved of the duties delegated to him so far as they relate to those works, and that his salary be reduced to £350 per annum, on the understanding that it be increased by £10 per annum until £400 is reached. This is equivalent to an immediate reduction of £100 per annum. The Worcester Board of Guardians have decided to accept the tender of Mr. Santonna for the supply of fittings for the electric light installation in a portion of the workhouse.

Kingswood (Bristol).—The chairman of the Urban District Council has mentioned that the matter of the extension of the electric light had been under the consideration of the Works Committee, who recommended that for the present it be deferred. On the recommendation being adopted, the chairman further said that he had had a conversation with Superintendent Matthews, the result of which was that the police would for the future make a note and report on all lamps in the district that were not lighted. To facilitate this duty, it was resolved to ask the electrical syndicate to number all the lamp-posts at Kingswood and Hanham.

Brazilian Submarine Telegraph Company.—The report of the directors for the half-year ended December 31 last states that the revenue for this period amounted to £104,926. and the working expenses to £36,771. After providing £4,841 for debenture interest and sinking funds and £1,490 for income tax, there remains a balance of £61,822; to this is added the sum of £1,501 brought forward, making a total of £63,324. First and second interim dividends, amounting to £39,000, have been paid, and £20,000 transferred to the reserve fund, leaving the sum of £4,324 to be carried to the next account. The receipts for the half-year include the sum of £1,500 dividend to June 30 on the Company's shares in the African Direct Telegraph Company, Limited.

Brighton.—A special meeting of the Town Council was called for yesterday to consider the question of the tenders for the electric lighting station. At the previous meeting of the Town Council it was decided, despite some opposition, to accept the decision of the Works Committee in favour of Messrs. Longley and Co.'s tender for the extension of the electricity generating station, although the tender of Messrs. W. A. Field and Co. was nominally lower. The committee have, however, reconsidered the matter, and have come to the conclusion that Messrs. Field and Co. have made substantially the better offer. They therefore asked the sanction of the Council for giving the business to the Brighton firm.

Edinburgh.—On Tuesday a meeting of the Town Council was held, at which Mr. Douglas asked Bailie Steel when the Cleaning and Lighting Committee intended reporting on the motion by Bailie Gulland on the subject of lighting by electricity George-street and the other streets adjoining? Bailie Steel replied that the matter was lying over in the meantime. Mr. Cameron asked if the Electric Lighting Committee intended to refuse change over switches to owners of private plant, thus depriving them of the public light unless at great expense The town clerk read a telegram from Councillor Mackenzie, who was in London, to the following effect: "Committee advised by Prof Kennedy change-over switches dangerous; might cause accidents, and should not be sanctioned."

Bury.—A meeting of the Bury County Council was held on Thursday last week, at which Alderman Parks said the Electric Lighting Committee had had a meeting, but as they had not been able to formulate their report there were no minutes to submit to that meeting. It might, however, be necessary to have a special meeting before the next ordinary meeting of the Council. Councillor Barr expressed the opinion that the Gas Committee and the Electric Lighting Committee ought to work well together, and that there ought to be no antagonism between them. He thought the gas manager and the borough engineer should work hand-in-hand in this matter, and he also thought that there ought to be an exhibition in the centre of the town as to how gas and the electric light should be used.

Tunbridge Wells.—The Lighting Committee of the Council presented the report which we gave in our previous issue at the last meeting of the Town Council. Councillor Wood moved its adoption, pointing out that their machinery was sufficient for more lighting than they had applications for in the compulsory area. The money would only be spent as required, and the mains would only be extended as a fair return was shown. Councillor Gower asked if the present addition to capital would enable them to supply the whole town, and when the light would be commenced. Councillor Wood said they could expect the light in June, and on Mr. Preece's authority the proposed capital would be sufficient for the present population, and if they wanted more it would pay for itself. The report was adopted.

Hastings.—The Public Lighting Committee of the Town Council have had under consideration the matter of the desirability of improving the existing public lighting arrangements at the baths. By their instructions a sub-committee viewed the place, and reported that in their opinion additional light was much needed on the south side of the promenade, and in accordance with a suggestion made by them, the committee recommended that, subject to satisfactory arrangements being made with the electric light company, an electric lamp should be placed at the south-east corner of the approach to the ladies' bath, and another at the south-west corner of the approach to the gentlemen's bath, provided the necessary consent of the baths company to the fixing of the same in those positions could be obtained, such lamps to be kept lighted until midnight. The report has been adopted by the Town Council.

New Windsor.—Notice is given that the Board of Trade have issued a provisional order under the provisions of the Electric Lighting Acts, 1882 and 1888, with a view to the same being included in a confirmation Bill about to be introduced into Parliament, to the Mayor and Council of New Windsor, authorising them to supply electrical energy for all public and private purposes within the borough of New Windsor and the Eton urban district. Copies of the provisional order have been deposited for public inspection at the office of the clerk of the peace for the county of Berkshire at Reading, and with the clerk of the peace for the county of Buckingham at Aylesbury, at the office of the clerk to the Eton Urban District Council, and at the office of the town clerk of New Windsor. Printed copies of the same can be obtained at the offices of the last-named at the price of 1s. each.

Pokesdown (Hants).—An adjourned parish meeting has been held to consider whether the parish should adopt the Lighting and Watching Act of 1883. Mr. W. Bolton, the chairman of the meeting, said it would be a grand thing if they could light the whole of the neighbourhood by electricity. Mr. Freak then read an estimate received from Messrs. Bergtheil and Young, electrical engineers, London, in which they offered to light the district with 20 lamps for £730. That sum would include a dynamo, a gas-engine to drive it, and the necessary apparatus, switches, cable, posts, etc. In addition to that sum, Mr. Freak explained there would be the cost of fixing the plant, which he estimated at £150. That would bring the total cost to £880. The annual expense—such as carbons, engineer's salary, gas for engine, etc.—would be about £245. Ultimately the meeting was adjourned.

New Mains in London.—The County Council have approved of new electric light mains being laid by the Hampstead Vestry in Arkwright-road, Ellerdale-road, Prince Arthur-road, in and across

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High-street to Gayton-road, Windsor-terrace, Belsize park and square, Lancaster place and road, and Strathray-gardens, Eton-avenue and England's-lane, Fortune Green-lane, Parsifal-road, and two portions of Finchley-road. The construction of a transformer-chamber under Finchley-road has been disapproved. Application has been received from the St. Pancras Vestry to lay mains in Gray's-inn-road and Wells-street. The proposed works were approved of, as were those of the Kensington and Knightsbridge Electric Lighting Company for laying mains in Hill-street, Knightsbridge The House-to-House Electric Light Supply Company intend to lay mains in Courtfield road and gardens and Collingham-road.

Portsmouth.—Mr. T. Codrington, Local Government Board inspector, has held an enquiry respecting applications to the Board from the Portsmouth Corporation to borrow, *inter alia*, £21,000 for extending the electric light. The application for this loan was supported by Mr. Alderman Ellis, chairman of the Electric Lighting Committee. He said that the light had already been so successful in the town that the income from the Corporation and private consumers had been sufficient to pay the interest and the sinking fund. There was a general outcry in the borough for an extension of the light beyond the present area, and the committee thought it desirable to make one loan to cover the cost of supplying the light to the main arteries of the borough. The mileage would be 8½, and 150 additional lamp-columns would be required. After supplying the public lamps there would still be enough power to supply 7,000 private lamps. There was no opposition.

Electric Haulage.—Messrs. Ernest Scott and Mountain, Limited, Close Works, Newcastle-on-Tyne, have secured the contract from the Huckleton Main Colliery Company, Thurnscoe, near Rotherham, for the electrical machinery in connection with a large endless-rope-haulage plant which they are fitting. The dynamo and motor are of Messrs. Scott and Mountain's improved type, and are capable of giving an output of 80,000 watts and 90 effective horse-power respectively. The plant is being so arranged that an additional dynamo and motor can be added as the colliery is opened out. The same firm are also busy with their new type of electrical fan, and have fans and motors of this description in hand for H.M.S.'s "Juno" and "Doris," and other vessels. These fans are being used in connection with the internal ventilation of ships, but Messrs. Scott and Mountain have made a considerable number of electrically-driven fans for induced and forced draught.

Birkenhead—A meeting of the Town Council has been held, at which the Finance Committee opened and considered tenders which had been received for the erection of the new chimney at the proposed electric central station, and recommended that the tender of Messrs. Holme and Green, of Liverpool, to execute the work for the sum of £850, be accepted, subject to certain conditions. Alderman Deakin moved the confirmation of the proceedings of the committee, and stated that Mr. Shoolbred, electrical engineer, assured them that he had already placed specifications before the Local Government Board, and that they had been approved by the technical specialists of the Department. He hoped if tenders in connection with the electric lighting scheme were accepted at the next meeting of the Council, he would be able to have a station ready for the supply of electric light by the month of September next. Mr. Gostenhofer seconded, and the proceedings were confirmed.

Extension of Business.—The Nalder and Harrison Construction Syndicate, Limited, of 47, Victoria-street, S.W., inform us that, owing to the large increase of business, and their intention to extend their field of manufacture, they have purchased the lease of the extensive premises known as the Invicta Works, Bow Common-lane, E., together with the complete efficient engineering plant and machinery in them, and that they will thus be enabled to carry out work of the very largest and heaviest description, in addition to their present output of electrical measuring and testing instruments, switchboards, etc. The syndicate intend to produce as soon as possible standard types of dynamos, motors, transformers, steam-engines, etc. As the work of transferring the existing plant at Trafalgar House and completing all new arrangements is of considerable magnitude, and one needing a certain length of time, it is the intention of the syndicate to keep the works at Trafalgar House open until the new ones are as nearly as possible complete, in order that there may be no unnecessary delay in the execution of orders. In the meantime all communications should be addressed to the head offices at Victoria-street.

The London Telephone Service.—The Clerk to the City Commission of Sewers on Tuesday read a circular which had been received from a committee of the London County Council asking the opinion of the citizens on the subject of the telephone service and its efficiency; whether it was efficient, or, if not, in what respects was it unsatisfactory. Mr. Pannell moved that the circular should be referred to the Streets Committee, with instructions to issue a similar circular to the citizens without delay. Mr. Alderman Bell objected to such information being filtered through a committee of the London County Council. Mr. Berridge said if the proposed course was adopted, the information would be obtained too late for it to be of any use. Mr. Wallace declared that the Commission of Sewers should be the mouthpiece of the citizens in so important a matter, and said when he received a circular similar to that read by the clerk he made up his mind not to allow the County Council to score off the Commission, which had a *locus standi* before the Select Committee. The largest users of telephones were in the City, and any information the citizens had to give should in his opinion come through that court, and not through the County Council. Mr. Pannell's motion was adopted.

Llandudno.—A syndicate has been formed for the purpose of obtaining an order authorising the construction of tramways in Llandudno and the districts of Colwyn Bay and Conway. The local authorities of the two latter districts have given their consent to the scheme, but the Llandudno District Council as a body have dissented from it, although as individuals many members favour the scheme. A vote of the inhabitants was taken some weeks ago as a preliminary test, but although it proved adverse the promoters believe that had all the voting papers been collected the result of the poll would have been in their favour. By Section 4 of the Tramways Act, 1870, the consent of the local authority is required where the promoters are not the local authority. The Board of Trade may make a provisional order authorising the construction of such tramway, if they are satisfied after enquiry that two-thirds of its length is proposed to be laid in the district or districts where the local authority or authorities do not consent thereto. In the present case the scheme, without the inclusion of Llandudno, cannot be proceeded with, and the promoters have therefore obtained counsel's opinion, which is decidedly in their favour. At a meeting of the promoters at Manchester, it was decided that a survey of the district should at once be taken.

Dowlais.—The annual meeting of the Dowlais Chamber of Trade was held last week, the president (Mr. J. King Price) occupying the chair. The Chamber having at a previous meeting decided to ask the Dowlais Gas Company for a reduction in the price of gas, seeing that the people pay 3s. 6d. per 1,000ft. as against 3s. 2d. paid in Merthyr, the secretary read a letter from the gas company declining to make a reduction. The President complained of the unfair way in which the tradesmen were treated by the gas company, and called attention to the fact that the Dowlais Iron Company were about to supply all their officials with the electric light. He thought it would put an end to the tyranny of the gas company if they could induce Mr. E. P. Martin to supply the tradespeople as well with the electric light. Mr. S. Makin said he should not like to see the town dependent for its light upon the works people. Mr. Morgan L. Walters said the gas company had but one object in view—namely, the highest dividend they could screw out of the people. He and many other speakers strongly urged a similar course to that pointed out by the chairman, but it was eventually decided that before approaching Mr. Martin the Chamber should make one last appeal to the gas company, and a deputation was appointed to wait upon them.

Keynsham.—A party has visited Keynsham and Kingswood, near Bristol, this week to examine Messrs. Parfitt's electric lighting system, upon which Prof. Silvanus P. Thompson has reported. He says "the system of Messrs. Parfitt is a system of series lighting applicable to incandescent lamps of various powers and sizes, and can be carried out either with overhead wires or with underground cables. Being a series system, it possesses the great advantage of economy in copper. It has also the incidental advantage that the most distant lamp, if of equal size, will work just as brightly as that nearest the station. The particular device, which is the essence of the system, and which is covered by Messrs. Parfitt's patent, is that of splitting each circuit of lamps into two cross-connected series, there being between each of the points of cross-connection two lamps which share the current between them, and two automatic devices. These devices, which are simple, inexpensive, and efficient, fulfil a double function—on the failure of any one lamp they immediately protect the second lamp in that section of the circuit from being over-run, and they protect the remaining lamps in the row from extinction. This mode of arranging and protecting a series circuit is, so far as I am aware, entirely novel, and I am satisfied that it is effective." The visit was in connection with the formation of a company to take up the patents.

Dublin.—The contract for the erection of the power station of the Southern Electric Tramway Company has been entrusted to Alderman Meade, who has already a numerous staff of hands at work in the initial proceedings. They will at first be engaged in the task of levelling off for laying the foundations of the power-house, which will be one of the most complete of its kind yet constructed in connection with any electric tram system. It will be built under the personal superintendence of Mr. J. Clifton Robinson, C.E., engineer of the company, on the site of the present depôt in Shelbourne-road, and as it will take in the existing stables and the adjoining plot of land, the structure will be of considerable extent, having a frontage of 200ft. by a depth of 300ft. The works are to be completed within the next three months, the contract including the whole of the generators, steam-engines, boilers, machine-shops, electrical works, and offices of the company. There will be accommodation for 40 new cars, which are being built for the electric equipment of the line by Messrs George F. Milnes and Co., of Birkenhead. During the present month it is expected that the double line of rails will be completed through the Pembroke township, and there is every probability that within the next three months the new line will be open to Blackrock Poles have been erected on both sides of Northumberland-road, next Ball's Bridge, these being 33ft. high and 125ft. apart. They are sunk 6ft. in the earth, which is concreted on the surface.

Ipswich.—A meeting of the Town Council was held on Wednesday, when the Electric Lighting Committee stated that, acting upon the resolution of the Council of April 25, 1894, that they should take steps to obtain an electric lighting order, they requested Prof. Kennedy to report generally upon the mode of lighting which would be most suitable for Ipswich, the best site for the central station, and the cost of the necessary works and plant. Prof. Kennedy visited Ipswich on several occasions, and, having made himself thoroughly acquainted with the district, presented his report. Since the appointment of that committee the advan-

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tage and greatly increased illuminating power which could be obtained at a trifling outlay by adopting the incandescent system of lighting with gas, had become more generally known and appreciated, and it appeared probable that recent scientific discoveries might lead to the adoption of other methods of increasing the illuminating power and purity of coal gas without increasing its cost. Under these circumstances, and having regard to the large expenditure involved in carrying out electric lighting in the borough, the committee recommended that no further steps be taken to obtain a provisional order for the present. The committee arranged with Prof. Kennedy that his fee for report, etc., should be 100 guineas, and they recommended that a cheque should be drawn for that amount. On the motion of Mr. Pratt, the discussion on this report was postponed till the next meeting.

The Loan to the St. Pancras Vestry.—A long report was presented on Tuesday to the London County Council by the Finance Committee on the subject of the limitation of time in connection with loans for electric lighting purposes, the subject coming up in reference to the application of the St. Pancras Vestry for a loan of £14,600. Finally they recommended: "(*a*) That, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of St. Pancras for a further loan of £14,600 towards defraying the cost of an electric light installation in that parish be granted to the extent of £14,300, on condition that the loan be taken up at once, interest being charged thereon at the rate of £3. 5s. per cent. per annum, calculated quarterly, and with the principal being repaid by such equal half-yearly payments of principal and interest combined as will repay the amount borrowed within a period of 42 years; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the consolidated loans fund. (*b*) That it be notified to the Vestry of St. Pancras that as they have elected to spread the whole of the initial cost of the electric light installation over 42 years, the Council will decline to sanction the raising of any loan to replace any of the works, plant, and machinery during the currency of the loan, and will expect the Vestry to provide for all such renewals as may be required during that period out of a sinking fund to be established, or out of maintenance account."

Rottingdean.—A meeting of the Parish Council has been held at which a letter was submitted from Messrs. New and Mayne, electric lighting engineers, of Westminster, offering to supply and erect not less than five street lights in the main streets not more than 60ft. from their mains and to supply the current to the lamps and maintain them for £4. 4s. per lamp per annum, the lamps to be lighted for 2,000 hours during the year, the lights to be of 16 c.p. It was eventually resolved, on the motion of Mr. Welfare, seconded by Mr. Savage, that a parish meeting be called to consider the advisability of adopting the Lighting and Watching Act for the parish with a view to dealing with this offer. The Council also had under consideration a letter which had been received from Mr Magnus Volk, acting secretary to the Brighton and Rottingdean Seashore Electric Railway Company, asking the consent of the Council to the company connecting the approach to the company's jetty with the Gap, which work it was stated, would not encroach on the Gap so as to offer any obstruction, while it was represented that the concealment of the old drain and the repairing of the pathway at that end would be an improvement to the appearance of the Gap. It was added that it was the desire of the company to open the jetty before Whitsuntide, and that the Marquis of Abergavenny's consent, so far as the sea beach was concerned had been obtained. Ultimately, after considerable discussion, Mr. Savage proposed that temporary leave be granted to the company to construct a sloping gangway to the beach and to effect a landing at the bottom of the Gap in such a manner that it should not interfere with the traffic. This motion was carried.

Torquay.—The Town Council on Tuesday received a report from the Electric Lighting Committee. The committee had ascertained that many of the large ratepayers in the area recommended for lighting with electricity by Mr. Trentham would be willing to take the light for private purposes if it were introduced by the Corporation, but, on the whole, they considered it would be preferable to adopt the scheme first propounded by Mr. Trentham and recommended by the committee on August 31, 1893. The committee had also considered whether it would be advantageous to deal with the matter in connection with the proposed refuse destructor, but they were of opinion that it would be better, for the present, to treat each as a separate question. The committee therefore again directed attention to Mr. Trentham's report, from which it would be observed that the estimated outlay, cost of maintenance, and probable income to be derived in the first instance, not including that obtained from meters, motors, etc., were: capital cost £17,403, annual cost £3,300. The estimated revenue per annum was at 6d. per unit £3,320, at 7d. per unit £3,820, at 8d. £4,320. The committee recommended that the necessary steps be taken, and application be made to the Local Government Board for sanction to borrow £18,000 for the purpose of providing a central station with plant and machinery under the bath saloons, and distributing mains for the compulsory area referred to in Section 17 of the Torquay electric lighting order of 1891. The report stated that Mr. R. Crocker voted against the recommendation. Alderman Kerswell moved the adoption of the report, which was seconded by Alderman Harrison. Mr. Butland said the Council must certainly keep the electric light powers in their own hands, but the present was not an opportune time for carrying out the work. Some thousands of pounds would shortly be wanted for completing works already in hand, and their debt was already heavy. He moved that the subject be referred back to the committee, and that application be made to the Board of Trade for an extension of the time for which the provisional powers were granted. Mr. R. Crocker seconded. Mr. Butland's amendment was carried.

Leeds.—The erection of the new General Post Office is now approaching completion. It occupies a central site. Amongst the fresh features that will manifest themselves when the opening takes place, probably none will be of greater interest than that which provides for the electrical equipment of the new building. This scheme, which has been designed by Mr. W. H. Preece, and carried out under the general superintendence of Mr. J. C. Chambers, superintending engineer, provides not only for lighting the whole of the building by the electric light, but also for putting electrical power to uses which it has not hitherto been applied to in any other post office. The current will be generated upon the premises, the boiler-house and dynamo-room being situated in the basement at the south-west corner of the building. The contract for the boilers has been placed with Messrs. Babcock and Wilcox. Three boilers of the water-tube type will be laid down, each capable of evaporating 3,000lb. of water per hour into steam at 125lb. pressure per square inch. The steam dynamos, three in number, are being supplied by Messrs J. H. Holmes and Co., of Newcastle, the combination being Willans engines, 60 h.p. indicated, driving Holmes dynamos direct. The dynamos will each supply 340 amperes of current at 108 volts pressure. The internal wiring will be carried out by Messrs. Lund Bros. and Co., of London. There are to be in all 36 arc and 563 incandescent lamps, chiefly of 16 c p. The arc lamps will be used in the large letter and parcel sorting-rooms, in the main telegraph-room, and also in the public office. The main switchboard for electric lighting in the dynamo-room, which has been specially designed, will be very handsome, and embody all the latest improvements in switches and measuring instruments. All these contracts (for which Mr. R. Gill is the resident clerk of works) are well in hand. The boilers are in course of erection, and a large part of the building has already been fitted up for the electric light. At the four corners of the main building, hoists connecting the different floors are being erected. By means of motors electrical energy will be used for working these lifts. In the present building telegraph messages are sent from one part of the building to another by means of hand pumps. This method will be abandoned in the new building, where containers will be erected, in which air under pressure, and in partial vacuum, will be stored. By this means telegrams will be driven in small carriers along tubes to the different telegraph departments within the building, and probably to and from one or two of the more important outside offices. The vacuum and pressure pumps that feed the containers will be worked by an electric motor.

Rochdale.—The borough surveyor's report as to schemes for lighting the Town Hall and other public buildings by electricity has been published and circulated among the members of the Town Council this week. Mr. Platt prepared the report for the information of the Electric Lighting Sub-Committee of the General Purposes Committee, and it was after carefully considering it that the sub-committee decided to recommend "the postponement of any electric lighting of the public buildings of Rochdale until the Corporation determines upon a general scheme for lighting a section of the town." This recommendation was subsequently approved by the committee, and on the 4th ult. the Town Council confirmed the minutes of the committee. Mr. Platt states that the more the subject is considered the less advisable it appears to hastily adopt any plan which will not, when required, adapt itself to conversion to a central electric lighting station. At the sanitary works the steam power available for the purpose of generating electricity is equal to 200 i.h.p., and under present arrangements 100 i.h.p. can be guaranteed continuously, excepting during the usual times of stoppage (Saturday noon to Sunday midnight) without increasing the staff of stokers. Owing to the non-central position of the sanitary works, Mr. Platt considers that this possible site for the generation and distribution of the electric light should not be adopted hastily, especially as the cost of steam production does not form an important portion in regard to the total cost of supplying electricity. Appended to the report are several alternative schemes showing the cost of installing and maintaining the electric light for use in public buildings. In one of these—proposing to make an installation in the basement of the Town Hall, to supply the Town Hall, the free library, and the technical school only—the estimated total cost appears as £5,202, and the estimated annual cost as £947. If, however, a central station for supplying the public with light were provided, the annual cost of electric lighting in all the public buildings would be reduced to £877, and that of lighting the Town Hall, free library, and technical school only would be £757. For the purpose of comparison, it is mentioned that the cost of lighting the public buildings by gas last year was £406. 10s. 4d., of which £354. 3s. 11d. was the share of the Town Hall, free library, and technical school. To this part of the report Mr. Platt appends a note stating that the figures given do not include anything for interest and sinking fund, and that the greater safety, cleanliness, convenience, and healthiness of the electric light ought to be taken into account in any comparison of the two illuminants. In relation to the estimate of total cost of electric lighting works, the report states that if the repayment of capital borrowed for this purpose be limited to a period of 10 years, the annual cost of the suggested installation at the Town Hall will be increased by about £170. Since the report was presented to the committee, it has been ascertained that the Local Government Board would limit the period of repayment to 10 years.

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PROVISIONAL PATENTS, 1895.

APRIL 29.

8398. **Improvements in the supporting and carrying of electric cables for conveying electricity over large areas, and to varying positions, whether for plough-driving, telegraphic, lighting, or other purposes.** Arthur Samuel Francis Robinson, 46, Lincoln's-inn-fields, London.

8421. **A new or improved automatic switch for electric welding and other purposes.** Reginald Falshaw, 1, Broad-street-buildings, Liverpool street, London.

8453. **Improvements in electrical switches and means of actuating same.** James Brockie, 28, Southampton-buildings, Chancery-lane, London.

APRIL 30.

8492. **Improvements in and relating to ships' telegraphs.** John William Ray and Robert Coleman Saxby, 26, Castle-street, Liverpool.

8493. **Improvements in and relating to ships' automatic reply telegraphs.** John William Ray and Robert Coleman Saxby, 26, Castle-street, Liverpool.

8505. **Improvements in the mode of and means for electrically transmitting articulate speech.** Charles Arthur Allison, 52, Chancery-lane, London. (John Absterdam, United States.)

8507. **Improvements in disconnection fuse-boxes.** Joseph Alexander Jeckell, Borough Electrical Engineer's Office, South Shields.

8564. **Improvements in electric alarms.** Alexandre Duceux, 55, Chancery-lane, London.

8573. **Improvements in electric cables and in their manufacture.** Willoughby Statham Smith and William Puddicombe Granville, 24, Southampton buildings, Chancery-lane, London.

8583. **Electro-automatic "block system" apparatus.** Alfred Berry and Joseph Lipkowski, 1, Queen Victoria-street, London. (Date applied for under Patents, etc, Act, 1883, Section 103, October 30, 1894, being date of application in France.)

8590. **Improvements in magnetic ore separators.** John Wendell Carter, Norfolk House, Norfolk-street, London. (Complete specification.)

MAY 1.

8603. **Improvements in terminals for electrical conductors.** Henry Reason and George William Goldring, 111, Gloucester-road, Brighton.

8637. **Improvements in secondary batteries.** Edward Clark, 84, West Ferry-road, Millwall, London.

8654. **A rectifier for alternating electrical currents** Frank Edward Beeton, 40, Chancery-lane, London.

8664. **Improvements in electric arc lamps.** Rookes Evelyn Bell Crompton and Edmund Arthur Norman Pochin, 55, Chancery-lane, London.

MAY 2.

8671. **Improvements in operating and controlling electrical and other cranes and hoisting machinery.** John George Fiegehen and Edward George Fiegehen, Stafford Lodge, Ampthill-road, Bedford.

8696. **Improvements in electric distribution and apparatus in connection therewith.** Arthur Wright and Robert Cornelius Quin, 26, Park-crescent, Brighton.

8726. **Improvements in electric motors, generators, and current-converting apparatus.** Silvanus Phillips Thompson, the Technical College, Finsbury, London.

8727. **Improvements in switches for varying electrical resistance.** Siemens Bros and Co., Limited, and Eduard Friedrich Hermann Heinrich Lauckert, 28, Southampton-buildings, Chancery-lane, London.

8729. **An improvement in secondary voltaic batteries.** Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London.

8731. **Improvements in electric arc lamps.** James Brockie, 28, Southampton-buildings, Chancery-lane, London.

8740. **Improvements in secondary batteries.** Mark Bailey and John Warner, 21, Finsbury-pavement, London.

MAY 3.

8764. **Improvements in distribution of electricity.** Arthur Wright, 26, Park-crescent, Brighton.

8801. **Improvements in telephones.** George Lee Anders and Edward Priddle, 33, Peak-hill-gardens, Sydenham, London.

8810. **Method of, and apparatus for, directly indicating the value of electrical resistances.** Siemens Bros. and Co, Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

8834. **An improved system of electric traction.** Otto Lindner and Charles Van Sweevelt, 70, Chancery-lane, London. (Complete specification.)

MAY 4.

8876. **Improvements in or connected with electric batteries.** Charles Percy Shrewsbury, Frank Laurence Marshall, John Cooper, and John Laskey Dobell, 57, Chancery-lane, London.

8904. **Improvements in primary and secondary battery plates.** Carl Ludwig Rudolph Ernest Menges, 45, Southampton-buildings, Chancery-lane, London.

8905. **Improvements in primary and secondary galvanic batteries.** Carl Ludwig Rudolph Ernest Menges, 45, Southampton-buildings, Chancery-lane, London.

8914. **Improvements in the preparation of chloride of lead for use in electrical storage batteries and for other purposes.** Alfred Roland Davis, 4, South-street, Finsbury, London.

SPECIFICATIONS PUBLISHED.

1894.

5391. **Electric railways and tramways.** Aldred.

7530. **Electrical glow lamps.** Edison and Swan United Electric Light Company, Limited, and Moffat.

7726. **Storage batteries, steam generators, etc.** Rollason and others.

9285. **Electrodes.** Kellner.

10978. **Electric measuring instruments.** Goolden and Evershed.

11059. **Varying the phases in polyphase electric currents, etc.** Rowland.

11136 **Regulating electric distribution systems.** Wood.

11323. **Telegraph lines and cables.** Muirhead and Fraser.

11587. **Electrolytic decomposition of solutions, etc.** Hulin.

12183. **Electric railways.** Parker.

12283. **Electric railways.** Langén.

12400. **Arc lamp regulators.** Suisse and Henniquin.

15455. **Telegraphic transmitters.** Howe.

20596. **Electric accumulators.** Hammacher.

22965. **Electrically heating and welding metals.** Th ompson. (Coffin.)

23858. **Measuring electric currents.** Nalder and others.

24745. **Electric light ceiling fittings.** Curley.

1895.

358. **Secondary battery electrodes.** Wershoven.

1546. **Electric switch.** Wright and Piper.

3779. **Arc lamps.** Albrecht.

5099. **Electric gas lighter.** Kass.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5⅜
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅞-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2⅜
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5¼-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	15½-15¾
—— 5 per cent. Debenture Stock	100	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	131-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	—
Electric Construction, Limited	2	⅝ ¾
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1½-1¾
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1⅛
Elmore's French Company	2	—
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	¾-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	9½-10½
—— Preference	—	12
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	7⅛-7¼
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge	5	7-7⅛
—— 6 per cent. Pref.	5	7-7⅛
Liverpool Electric Supply, Ordinary	5	7 11/16-7 13/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8¾ 9
—— Pref.	10	14-14½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	⅛-⅜
Metropolitan Electric Supply	10	10-10½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5⅛-5⅜
—— 6 per cent. Cum. First Pref.	10	15⅝-16½
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Nom. Cum. Third Pref	5	5⅜-6
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7½-8
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5⅜-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	7⅞-8¼
—— 7 per cent. Pref.	5	8⅞-9¼
Swan United	—	—
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7½-8
Yorkshire House-to-House	5	5⅛-5⅜

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NOTES.

Book Received.—"Telegraphy," by W. H. Preece, C.B., F.R.S., and J. Sivewright, M.A., K.C.M.G. Eleventh edition. Published by Messrs. Longmans and Co. Price 5s.

Lectures to Students.—On Tuesday, May 28, Mr. James Swinburne will commence his usual course of lectures on "The Construction of Dynamos, Alternators, and Transformers" to the students of the Electrical Standardising, Testing, and Training Institution, at Faraday House, Charing Cross-road, W.C.

The Telephone Service in the City.—The circular issued by the Commission of Sewers, asking for an expression of opinion by telephone users in the City as to the merits and demerits of the existing service, has been answered by considerably over a thousand persons, the great majority of whom appear to be in favour of a more efficient service. Although the circulars were only issued on Wednesday, 500 replies to it were received early on the following morning.

Insulator with Resin Base.—M. Gentzch prepares an electric insulating material in the following manner. He heats resinous substances such as ozokerite, amber, and asphalte in a retort, at a temperature of 400deg. C., until the condensable or gaseous volatile products are liberated. The result is a black residue having when cold the consistency of wax or dry resin, and capable of being used either alone or in conjunction with guttapercha, other resins, mineral powders, or with sulphur, as a cable insulator. The material, it is said, has sufficient plasticity to lend itself readily to the turnings and twistings to which the wires of cables are generally subjected. The proportions of the raw substances used should be preferably ozokerite 50 parts, yellow amber 45 parts, and asphalte five parts.

The Telephone on Railways.—At a recent meeting of the Society for the Promotion of Local and Street Railways in Vienna, Herr Anton Watzka, of the Austro-Hungarian State Railways, gave a paper on the use of movable field-telephones in railway service, illustrating his remarks by the aid of a number of specimen instruments lent for the occasion by the Wiener Mikrophon und Telephonfabrik J. Berliner. Especially useful, he said, were the apparatus he was discussing in case of accidents and breakdowns, where it was necessary to have an easily portable and quickly usable means of transmitting and receiving information or instructions. Specific cases of their utility on several local lines were mentioned; and the speaker, in conclusion, maintained that we had, in the field-telephone, a simple, reliable, and cheap method of providing for any emergency in which it was essential that communication should be rapidly established, and where ordinary telephone wires were not available.

Electrometallurgy.—At the recent meeting of learned societies—Congrès des Sociétés Savantes—in Paris, M. H. Moissan remarked, in the course of a dissertation on electrometallurgy, that he was convinced that the treatment of metals by means of the heat of the electric arc would develop more and more largely, and that thus the forcing upon the ore of the impurities of coal would be obviated. He observed, too, that during his extended electrometallurgical researches he had had occasion to deal with currents of very diverse intensities. He commenced, he said, with the very modest engine at the Ecole de Pharmacie de Paris—one of 4 h.p. Then, when his appetite was whetted for this class of work, he accepted the hospitality proffered him by Colonel Laussedat, of the Conservatoire des Arts et Métiers, who placed at his disposal a 45-h.p. machine. Finally, the director of the Société Edison, M. Meyer, allowed him free access to the fine electric lighting station in the Avenue Trudaine, where, with his collaborateur, M. Lebeau, he conducted experiments with engines of from 100 h.p. to 300 h.p.

A Curious Electrical Discharge.—Mr. Gus Schade, of Anaheim, Cal., writes as follows to the *Scientific American*: "I am making asphalte pipe. The process is as follows: Crude asphaltum and gravel, equal parts by measure, are each heated in separate kettles to 400deg. F., then both are mixed together and filled into sheet-iron moulds. The space between the moulds is maintained by a cast-iron ring on the bottom and the moulds are held to that ring by inside and outside wrought-iron rings. After the moulds are cooled off, which takes time, according to the size of the pipe, from two to eight hours, they spring off from the pipe after the wrought-iron rings have been removed and the moulds tapped with a hammer. Just at the moment the moulds spring off there can at times be seen large sparks between the sheet iron and the pipe. By having my hands on the pipe and the moulds I received sometimes such heavy shocks as to draw my arms together. Men working for me have experienced the same. The object of this letter is to find out if you or any of your readers can explain how this electricity—for such is what I judge it to be—accumulated there, and why it discharges just at the moment the moulds are taken off. The editor thinks the description suggests that a condenser is formed by the combination, which is discharged on opening the mould. Whence the charge is derived is not clear."

The British Association.—The programme of the Ipswich meeting, which will commence on Wednesday, September 11, has been issued. The president will be Captain Sir Douglas Galton, F.R.S., with Prof. Hicks, F.R.S., president of the Mathematical and Physical Section; Prof. R. Meldola, F.R.S., president of the Chemical Section; W. Whitaker, F.R.S., president of the Geology Section; Prof. W. A. Herdman, president of the Zoology Section; H. J. Mackinder, M.A., president of the Geography Section; L. E. Price, president of the Economic Science and Statistics Section; Prof. L. T. Vernon Harcourt, president of the Mechanical Science Section; Prof. W. M. Flinders Petrie, president of the Anthropology Section; and W. T. Thistleton-Dyer, president of the Botany Section. We notice that Prof. Silvanus Thompson, F.R.S., is to deliver one of the evening lectures on the subject of magnetism in rotation. This lecture will be delivered on Friday evening, September 13. There is a suggestion which we would offer to the Physical Section—or rather we would make for the third or thirtieth time—and that is that they should emulate in some measure the business method of the Mechanical Section, and so to assist in a better reporting of the various papers, by having the abstracts in the hands of the secretaries previous to the reading of the papers. It is almost impossible for a scientific expert to report the gist of a paper which is given in abstract and in pantomime, with a promise of future extension, and totally impossible for the ordinary reporter so to do. If the British Association, or, rather, one or two particular sections of it, are to recover from the dreary monotony of empty benches, more attention will have to be given to the quality of the papers sent in and to the possibility of their being adequately reported for the general reader.

Electricity and Prestidigitation.—The powerful aid which modern magicians are able to derive from the

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subtle electric current is common knowledge, and little wonder is there consequently that from time to time these wizards startle the wonder-loving world with new and striking developments in their "black art." One of the latest efforts in this direction is that of M. Trouvé, who, through the intermediary of the prestidigitateur Roskoff, utilises the telephone in the production of that interesting attribute known as *double vue*, or second sight. The medium, whose task, as we know, is to describe for the benefit of the audience unseen objects selected by them, receives, by the Trouvé method, the necessary information by means of two very sensitive auricular telephones. These instruments—the size of a two-franc piece and from 8 to 10 millimetres thick—consist of a small metallic box, in which there is a tiny electromagnet, while the lid of the receptacle represents the diaphragm. The conductors form, in the first place, a flexible semicircle, which keeps the telephones in proximity to the ear, and they are then continued down the body, hidden in the clothing, and out by the soles of the shoes to the carpet, under which the connections are secretly disposed. The receivers and the wire semicircle are concealed by a wig which the medium should wear, together with a costume in keeping with this hirsute adornment. The public will never suspect the existence of electrical apparatus, but as an additional precaution connections should be placed at various points in the room, and the subject, blindfolded and with his back to the audience, installed successively at each of them, the telephones being connected with a battery and a microphone fixed "behind the scenes." The articles which he has to describe are then so placed on a table that a confederate at the hidden transmitter may easily see them by peering through a small orifice, and thus communicate to the medium in a low voice the necessary particulars, which he repeats for the edification and to the no little astonishment of his auditors.

The Mersey Railway.—There is quite a plethora of important electrical news concerning Liverpool this week. First, there is the report, mentioned in another column, of Sir Frederick Bramwell relative to the acquisition by the Corporation of the plant and goodwill of the Electric Supply Company, for the sum of £400,000; and then there is the Bill of the Mersey Railway, the "underground" of Liverpool, seeking to have that brilliant but not very fortunate steam undertaking converted into an electrical line, which came before a committee of the House of Lords on Monday. Mr. Monroe, for the promoters of the Bill, said that from the experience of the working by electricity of the South London Railway, with a heavy gradient, there was good reason to believe that a great economy would be effected in the cost of working the railway were electric traction adopted, while the public would have a more frequent train service. Mr. A. Sarle, general manager of the London, Brighton, and South Coast Railway, and for the last four years official receiver of the Mersey Railway Company, stated that it was estimated that there would be a saving of about £14,000 a year in cost of ventilation and in working the railway by the new method. The cost of the change, supposing they required new rolling-stock, would be, he said, £80,000, but it was believed that the motors proposed to be used could be applied to the existing rolling-stock, and that would save about £25,000 of the first estimate. Sir Douglas Fox spoke strongly in favour of the use of electrical traction in a case of this kind, and was quite certain from experience on the Liverpool Overhead Railway, and from experiments first made on the Baltimore and Ohio Railway, that the plan was perfectly feasible and economical. Mr. A. Siemens estimated that the cost of working would be one-third less, and he said that there was nothing to prevent the construction of electro-locomotives sufficiently powerful for goods trains. With an insulated return, he remarked, there would be no interference with railway signals or electrical wires. The committee, in the event, said they would find the preamble proved subject to words being inserted which would make it quite clear that the spirit of the agreement of May 14, 1894, as to through traffic, was agreed to.

Electricity Direct from Coal.—The endeavours of scientists and inventors to convert directly the potential energy of coal into electrical energy have received a fresh incentive from the interesting experiments of Dr. Borchers. So alluring are the rewards that follow the solution of this problem that men known for their conservative attitude in similar questions have hailed with extravagant expressions of delight the seeming results of the German electrometallurgist. It is true the latter deserves high credit for testing his ingenious idea, yet from his own account of the facts brought out in his experiments it is not sure that his theories are established. Such failure, it is only just to note, could not have been foreseen from the standpoint of our present knowledge of electro-chemistry. In the extensive discussion of Dr. Borchers's work, which appeared in various technical and scientific journals, one point has been altogether ignored, and this point is of such essential importance in the problem of the conversion of the potential energy of coal into electric energy that it deserves to be fully elucidated. This point is the relation of chemical to electrical energy. Dr. Borchers erroneously supposed that it would be possible to obtain an amount of electrical energy from the reaction $2CO + O_2 = 2CO_2$ that would be equal to the heat of formation of as much of the quantity of the reacting substances as take part in the transformation. Since Helmholtz has shown that such a view does conflict with facts, it is not legitimate to assume its correctness, still less to base upon it efficient calculations, as has been done by Drs. Borchers and Ostwald. Mr. A. H. Bucheru, in a paper read on this subject in America, concludes that the maximum E.M.F. we can expect to gain from the combination of carbon monoxide with oxygen is 1·406 volts. Dr. Borchers claims to have succeeded in obtaining 0·5 volt, but not in a commercial form of apparatus. For reasons which were well stated by the latter, it is more expedient and apparently easier to utilise the combination of carbon monoxide with oxygen for the generation of electric energy, instead of that of carbon with oxygen. The work done by Dr. Borchers, though not crowned with success as yet, is, nevertheless, of high value on account of its instructiveness. It indicates in its general features the path that has to be followed for accomplishing a most important industrial task, the fulfilment of which we hope this century will yet witness.

Communication with Lightships.—The third report of the Royal Commission on the question of electrical communication to lighthouses and light-vessels has just been issued. The Commissioners since they issued their second report have considered some further inventions for establishing electrical communication with light-vessels, but still consider that the "Sunk" is the best system of continuous connection which has yet been brought to their notice. In this system, which has been maintained on four vessels since 1886, the ship is moored by two or more chain cables attached to mushroom anchors and shackled to the lower part of a patent swivel, to the upper end of which are shackled the vessel's two bridle chains. The electric cable on its way

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from the shore passes through the centre of the swivel, and entering the bow of the ship between the knightheads, is coiled on a drum fitted to a revolving frame placed between decks, by means of which turns made in the cable when the lightship swings round with the change of tide can be taken out. This system permits of the free use of the telephone, which in the opinion of the commissioners is an important advantage. After giving an account of the faults which have occurred in the various cables used for these purposes, the report gives the following list of occasions on which the connections have been of valuable services to the shipping community: Kentish Knock light-vessel (connected March 14, 1894), on six occasions; Goodwin (North Sand Head) light-vessel (connected March 24. 1894), on nine occasions; Hasborough light-vessel (connected October 2, 1894), on two occasions; Shipwash light-vessel (connected November 17, 1894), on one occasion; Gunfleet pile lighthouse (connected October 2, 1893), on 19 occasions. No use for life-saving purposes have been made of the cables to the Lundy lighthouse (connected July 18, 1893) and the Tuskar lighthouse (connected September 10, 1894). As regards shore lighthouses, use had been made of the electrical communication for such purposes with the Start Point lighthouse on four occasions, Needles lighthouse on three occasions, South Stack lighthouse on two occasions, Nash lighthouses on two occasions, Bull Point lighthouse on one occasion, Point of Ayre lighthouse on one occasion, Douglas Head lighthouse on one occasion, Hook Point lighthouse on one occasion. The report concludes with a list of further communication needed, and also gives all the details as to the various urgent calls for assistance which have been forwarded to the mainland or to points whence help could be rendered. We trust that the recommendations as to extensions will be speedily carried into effect.

"A Little Knowledge is a Dangerous Thing" (Pope).—Our contemporary *London* has, in its issue of May 9, aired its opinions as to consulting electrical engineers. Unfortunately, these opinions must be largely discounted, in that they are evidently written with a bias. The immediate object of the article is a description of the central station at Islington, and it goes out of its way to run down the consultant. This is what it says: "Islington never employed a consulting engineer. The consulting engineer is very much like a physician: he thoroughly understands theory; but all sensible people call in the surgeon—the practical man—when practical work has to be done. There is hardly a consulting engineer in existence who has had experience of the practical day-to-day running of an electric lighting station for six months together. Consulting engineers have profited largely from the general ignorance prevailing as to electric lighting. A municipality, anxious to keep pace with modern developments, decides to establish the electric light. The consulting engineer is at once called in; he is usually supported fully and fee'd in like manner. What happens? When the undertaking is complete a superintending engineer must then be placed in charge, and in nine cases out of ten before he, as a practical man, can take up the new duties he is bound to rearrange the whole system, often at considerable cost, otherwise failure becomes inevitable. The fact is the superintending engineer ought to be appointed the day the works are put in hand, instead of on the day of their completion, so that he can exercise a personal supervision over the construction of the undertaking he will eventually have to control. Islington has proved that the consulting engineer is not necessary. They first of all made their own enquiries, and then before beginning to build appointed a superintending engineer of first-class experience." Now, a paragraph of more absurd and ignorant twaddle never emanated from the pen of a responsible journalist. We contend that the consulting engineer is a necessity. It is impossible to point a moral by reference to electrical work, because someone endowed with the folly of ignorance would be sure to attribute personality. We would, however, ask our contemporary if it would argue that the man who drives and manages the locomotive must of necessity be the best man to design one. As a matter of fact, the driver of an engine may be totally ignorant of the first principles of design. Nor does it hold good that the best designer of a locomotive is the best driver. Every man to his place, and in his place. The bricklayer is not an architect, and the architect is not a bricklayer. The best managers of central stations are not necessarily the best designers; indeed, we should expect them to turn out to be about the worst. There is no disparagement intended; but reading between the lines of this paragraph from *London*, it is easily seen that the desire is to encourage narrowmindedness and mediocrity.

Resonance in Alternating-Current Lines.—Messrs. Edwin J. Houston and A. E. Kennelly have read a paper on this subject before the American Institute of Electrical Engineers, of which the following is an abstract. In a paper, by one of the authors, on the subject of "Impedance," read before the institute on April 18, 1893, the drop of pressure in conductors carrying alternating currents, and assumed to possess no capacity, was considered. In the present paper, the authors consider the conditions of current and pressure in an alternating-current circuit, possessing electrostatic capacity as well as inductance, resistance, and leakage. The authors present formulæ expressing the variation of electric current and pressure in an alternating-current circuit under the most general conditions, and in its simplest form. They give calculations for the pressure and current in any alternating-current circuit by a graphical method, presenting a chart which gives by inspection the polar co-ordinates of a vector point, representing the hyperbolic cosine or sine of a given vector whose rectangular co-ordinates are known. They also investigate the effects of static capacity and of capacity and inductance on the delivery of energy at the distant end of an alternating-current circuit. The conclusions arrived at by the authors are as follows: (1) The combined effect of capacity and inductance is to produce a tendency to resonance. (2) The tendency to resonance is favoured by high frequency, high insulation, high inductance, high capacity, and high conductance. (3) When the line is free at the distant end, the resonant effects are more pronounced at that end than at the generator. (4) The determining factor for the production of resonance is the angle of the vector geometric mean conductor impedance dielectric admittance, and rapidly increases with the same. (5) The complete wave-length in a resonant line is 2π times the length, in which the reactances of the inductance and the capacity are equal, the maximum difference of pressure or current strength being exhibited in one-quarter of this wave-length. (6) When resonance occurs, the current and pressure in the circuit are not in phase except at their maximum and minimum values—*i.e.*, at the crests and troughs of the waves. (7) In resonant circuits, the lag of the pressure and current is 90deg. between any successive pair of maximum and minimum values. (8) In ordinary lines, worked sinusoidally at ordinary frequencies, resonant effects are practically negligible. (9) Prominent upper harmonics in the E.M.F. of the generator may sometimes give rise to appreciable resonant effects, although the resonance to the fundamental frequency may be inappreci-

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able. (10) A certain amount of capacity tends to increase the plant efficiency of the generator, and is, therefore, economical, but marked resonance in a line not only ceases to be economical, but is actually wasteful. (11) Although, on a large scale, less energy can be delivered at the distant end of a powerfully resonant line than on a non-resonant line, yet a greater current strength can in some cases be delivered over a powerfully resonant line.

Telephones.—The Select Committee of the House of Commons on the Telephone Service heard further evidence on Tuesday, Mr. Arnold Morley (the Postmaster-General) presiding. Major-General Webber, C.B., formerly divisional engineer for postal telegraphs, who had charge of the telegraph service in the Egyptian War, and since his retirement from active service had been managing director of the Bell-Edison United Telephone Company, stated, in answer to Sir C. Cameron, that he was not altogether in favour of Government monopoly. His view of the possible extension of telephony made him think it might get beyond the management of even such a great department as the Post Office. In his opinion the Post Office were right in securing the arteries of the system, and in thinking they could manage better than anyone else that part of the system which was essentially used for commercial purposes; but as regarded what he called the great system of capillaries, which might come into existence in this country in the future, it might be wise to leave that in the hands of private enterprise. There were two forces which had prevented the development of the telephone in this country. One was the natural caution of the Post Office in preventing by every means in their power the extension of the telephone from fear that it would compete with their telegraphs. Another was the inception of the monopoly which, having the possession of the patents, could prevent anybody else using it, and the fact that every sub-company was really the creature of the head company, and therefore the policy of the head company prevented the operations of all the minor sub-companies. In London the engineering arrangements for telephone extension had grown up haphazard to the most lamentable extent. To establish one great centre of exchange was impossible in the City, because there was not space to lay down, radiating from one centre, a sufficient number of tubes to cover the surface which would probably be required. In order to meet that difficulty, he proposed to the late Duke of Marlborough to establish eight telephonic exchanges at different points in the City, with the wires conducted in tubes underground. There was no engineering difficulty in establishing such a system now without the abomination of overhead wires. The plan he contemplated would accommodate 28,000 subscribers in the City alone. Each of these eight exchanges might have 3,000 subscribers, and would be capable of serving subscribers outside for a distance of three-quarters of a mile on the north and half a mile on the south of the river, so that there was the nucleus of a system in London which ought to serve 50,000 subscribers, taking an area outside the City of three-quarters of a mile in every direction. As regarded rural districts, he thought the telephone ought to take precedence of light railways, and he described a scheme by which a call office might be established in every village and hamlet of a county, the call office being connected with the market town, and conversations allowed at 2d. each. In answer to the chairman, the witness stated that the subscribers on each of the eight City exchanges would pay a minimum charge of £8 a year, with an extra toll for a connection with another exchange, or an increased subscription to be connected with all the eight exchanges. He had not formed an estimate of what this inclusive charge would be, but probably it would be about £16 for any place within the City area.

Light and Electrification.—Prof. O. J. Lodge has written an article in the current number of *Science Progress* bearing this title. Anything that Prof. Lodge writes is worthy of the closest attention, and in this article he not only gives certain corroborative evidence of his own experience, but an epitomised history of the experimental evidence in regard to the text of this article. This text is summed up in the first three paragraphs as follows: "If an ordinary gold-leaf electroscope with a freshly-scraped zinc cap or knob is charged with negative electricity, and is then exposed to the unfiltered rays of a source of ultra-violet light, its charges will leak away rapidly. If, further, the electroscope so treated be extremely sensitive, it will be found, not only to lose its negative charge, but to acquire a slight trace of positive charge under the action of light. These are the simple and fundamental facts of what is virtually a new subject or branch of physics, the subject of photo-electric action, the influence of illumination on electrified surfaces." It will be well, perhaps, to indicate the points of the article, but at present we can do no more, but must leave readers themselves to carefully consider what the author says upon the subject. After a summary of historical work, the author enters into the question of experimental details, and points out that a demonstration of the fundamental fact can be made with very simple appliances (though unless they are properly arranged it is easy to fail), coming to the conclusion that the arc light is the most powerfully active source, especially if it is made extra long, still more if a little zinc is placed in the positive crater for volatilisation. Then, the kind of metal exerts considerable influence, and it appears that the order of metals in photo-electric power, when tested by their discharging action for negative electricity, is the same as their order in the voltaic series, and the facts discussed under this heading clearly suggest some chemical or semi-chemical explanation. The author then considers the discharging action of metals for positive electricity, which is very different to the discharge of negative, his own experiments going to show that as metals get dirty the rates of leakage of negative and positive become more comparable, and in the case of cobalt, the positive discharge he has found to be even faster than the negative. One might interpolate here a question as to the fundamental property of electricity, and to ask how equilibrium is continued between the positive and the negative states, in that there cannot be anywhere a greater positive charge than there is a corresponding negative charge somewhere. The question of fatigue, the action of non-metallic substances, and plants are next considered, and there is a promise given that in a future article the author will discuss the final aspect of some facts stated from the point of view of theory; but he again maintains that it is plain in the experiments on metals, at any rate, that a quasi-chemical origin is indicated for the discharging power. As regards the effect of magnetism, the singular observations made by Elster and Geitel are given. They found that if the lines of magnetic force agreed in direction with the lines of electrostatic force they had no appreciable influence on the discharging power of light, but that as soon as the magnetic and the electrostatic lines crossed, the discharging power of light was definitely diminished and interfered with. As we have said, the present article is a summary of the more prominent and interesting facts connected with the subject, and a future article will attempt to collate these facts and consider their bearing with regard to a possible explanation.

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CHELTENHAM ELECTRICITY WORKS.

If we mistake not, a previous attempt has been made to supply Cheltenham with the electric light, but not under the auspices of the Corporation. Now, however, that the authorities themselves have taken the work in hand we find every indication of success, as, indeed, will be gleaned from the following brief description of the central station now opened. Of Cheltenham itself we shall say little, for, as an old writer says, it "has been rapidly rising into note as a fashionable place of resort, and is at present eminent for the elegance of its buildings, the extent and variety of its accommodation, and the rank and number of its visitors." Indeed, any praise of ours as regards this fashionable town would be out of place, and we therefore content ourselves with simply saying that both its governing body and its officials are fully alive to the requirements of a modern health resort, and strain every nerve to comply with such requirements.

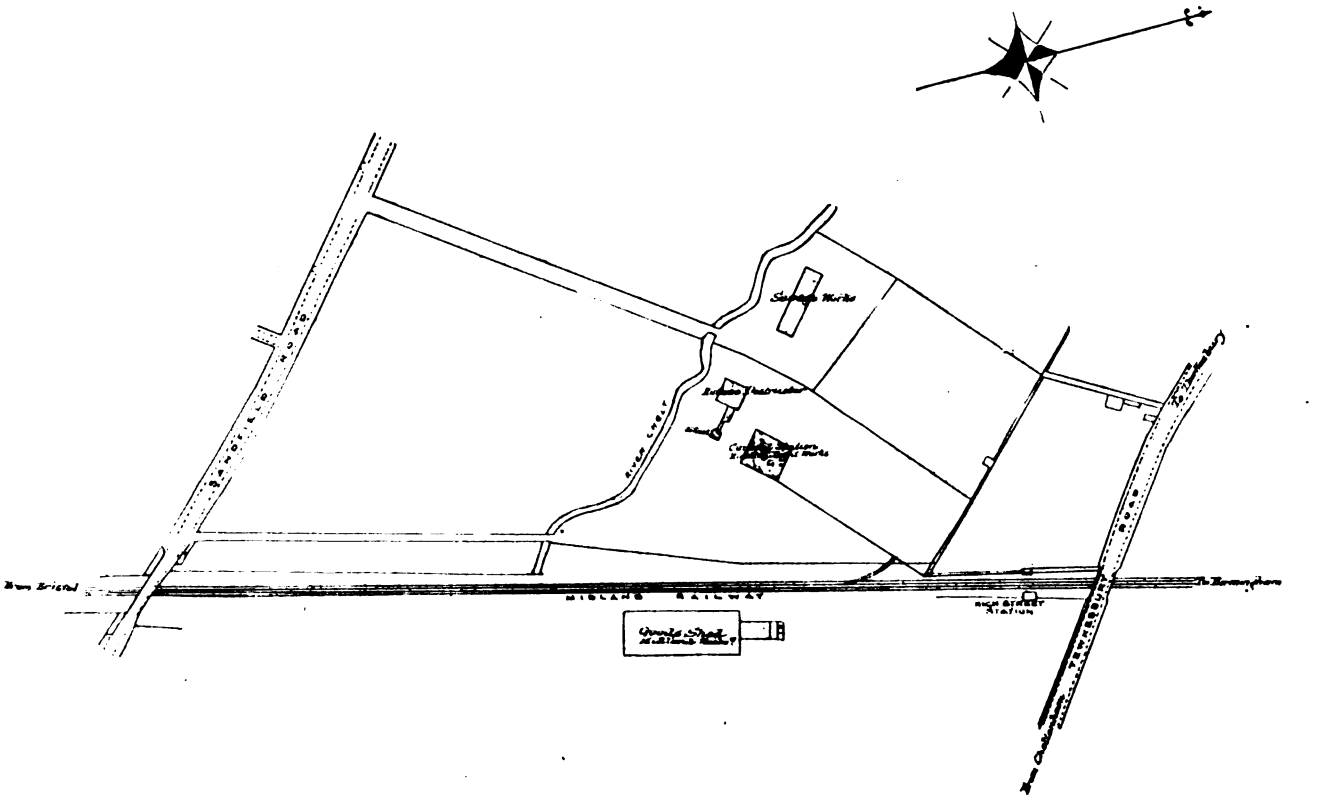

FIG. 1.—Plan of Site of the Electric Lighting Works, Refuse Destructor, and Sewage Works at Cheltenham.

Before describing the generating station and the system of distribution adopted, it may be of interest to briefly recall the history of the movement which has led to the present results. The circumstances under which the order was obtained date back as far as 1889.

Prior to that year the question of electricity supply had not been wholly unthought of in the Council-chamber, but it required the pressure of a threatened invasion of private speculation to stimulate the governing body to a definite policy. The presence of no less than six trading companies in competition before the Board of Trade for the privilege of lighting Cheltenham by the electric light involved three possible alternatives. One of these—that of mere passivity—was clearly out of the question, and there remained the choice of accepting the overtures of a company and consenting to its admission under an arrangement for subsequent purchase, or of excluding private enterprise by taking advantage of the preference given by Government to municipal supply. The Corporation unanimously chose the bolder course. The principle that public services should be in public hands is too late in the day to challenge. The Corporation has throughout adhered to the policy it originally laid down. The provisional order, obtained in the spring session of 1890, specified two years as the limit within which the governing body of the town was free to formulate its scheme, in accordance with the obligation entered into precedent to the acquisition of powers as against a company. Had the Corporation, after temporarily making sure of its position, been disposed to adopt a merely obstructive and dog-in-the-manger attitude, it would not have been suffered to do so beyond the period stated. In March, 1891, when the larger half of the time limit had still to run, the Department in London wrote reminding the Town Council of the responsibilities it had assumed. The Electric Lighting Committee had already paid visits of inspection to various electrical works in London and elsewhere, and on the recommendation of that body the Corporation responded to the pressure of the Board of Trade, and the engineer determined to adopt the ash destructor site (Fig. 1) as the place for the central station, which favoured the high-tension system of distribution. At the same time the borough surveyor was authorised to obtain expert assistance, with the view to a system being agreed upon.

Of the incidents of the long period of enquiry which followed it is unnecessary to say more than that the unanimity which had decided for municipal control gave place to considerable criticism of details and methods, with the result, however, that the scheme put forward by the surveyor, with the sanction of Prof. Ayrton, and subsequently endorsed by Mr. Preece, as *amicus curiæ*, carried conviction to the minds of objectors, and was adopted by a majority of the Council favourable to the policy of Corporation enterprise as originally affirmed. The final determination of the matter was arrived at in August, 1893, when the limit of time specified in the order was on the point of lapsing.

The scheme (based on the system of alternating high-tension current with transformers) involved an initial outlay of £16,000, leave to borrow which was, after the usual official enquiry, obtained from the Local Government Board

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acting in conjunction with the Board of Trade as the authority having the oversight of such undertakings in their technical and engineering aspect. The machinery of central administration moves slowly, and though the application for borrowing powers had been made in August, 1893, it was not until March last year that the requisite sanction was forthcoming. The official appointment of Mr. M. H. Kilgour as borough electrical engineer, who had been for some time previously assisting the surveyor, followed closely upon the selection of tenders for the various departments of the work—a selection in which special circumstances called for some delay—and, finally, after the first stone of the station had been laid by the mayoress at the beginning of October, a long spell of bad weather seriously retarded operations, both in the laying of the mains and in the completion of the machinery. From one cause and another, the commencement of the work had, in fact, been driven off to too late a period of the year. However, if the realisation of the scheme has proved a more tedious process than was expected, it is satisfactory to know that it has been marked at every stage and in every detail by the thoroughness which is immeasurably to be preferred to haste. For much of our historical information we are indebted to the *Cheltenham Examiner*.

The Electric Lighting Committee is composed of the following gentlemen: Alderman Norman (chairman), the Mayor, Alderman Thoyts, Councillors Dimmer, Lawrence, Parsonage, Wheeler, and H. Waghorne. The chairman (Alderman Norman) has taken an active part throughout in the electric lighting question, and the committee has been admirably advised by the borough engineer and surveyor, Mr. Joseph Hall, who has had full control of the whole of the works. The specifications were drawn up by him, and also some considerable part of the work, notably the laying of the mains, has been done under his supervision by workmen employed by the Corporation. In the electrical problems Mr. Hall has received valuable advice from Mr. M. H. Kilgour, the borough electrical engineer, who has given great attention to the details of the plant.

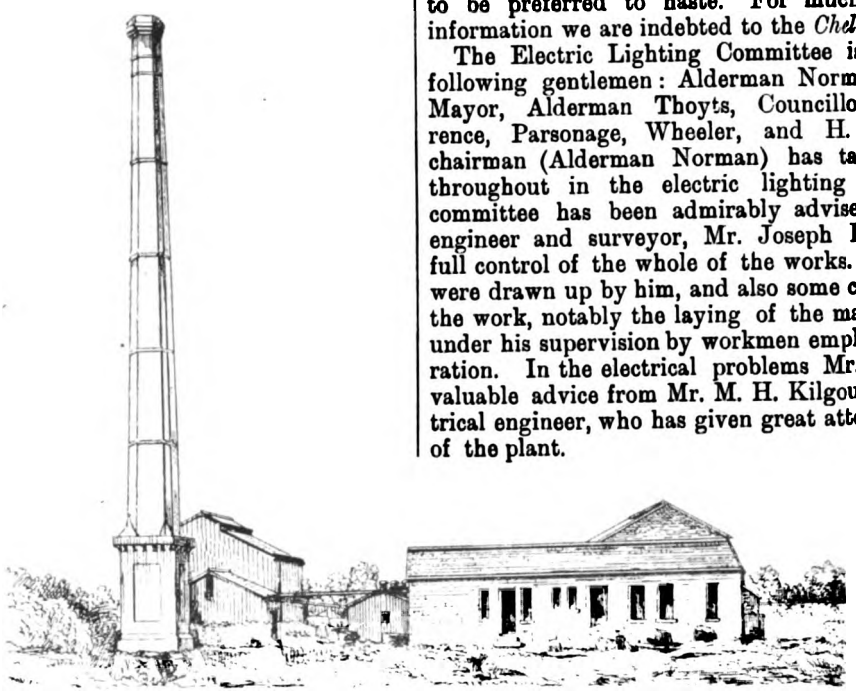

FIG. 2.—View of the Cheltenham Electric Lighting Station, Refuse Destructor, and Sewage Works.

The advantage to a town of having its public wants supplied under the direction of its own engineer is again evident in the case of Cheltenham. By placing the electric lighting station (Fig. 1) near the refuse destructor the following economic advantages accrue: (*a*) the steam generated by the necessary destruction of the house rubbish can be utilised to generate electricity, which can be sold; (*b*) this steam will be enough to run the engines during the lightly-loaded periods of the day, and hence ease the work on the boilers and save the boiler-attendants' wages; (*c*)

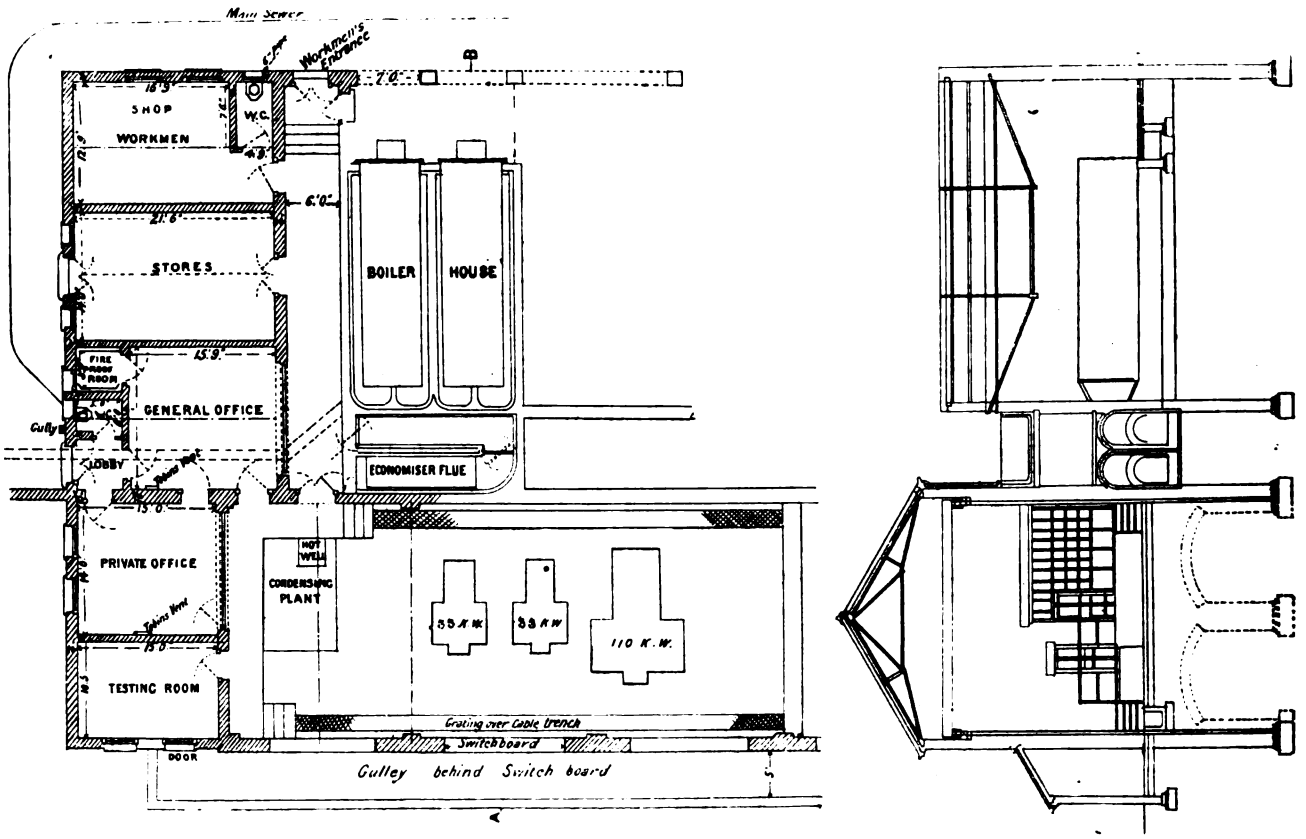

FIG. 3.—Plan and Elevation of the Cheltenham Electric Lighting Works.

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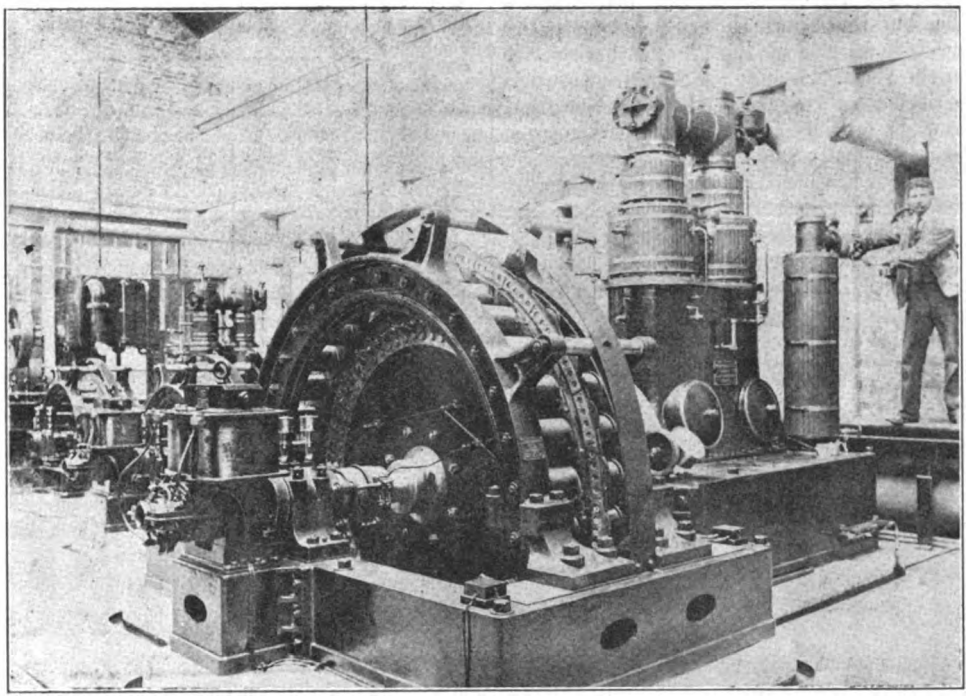

FIG. 4.—View of the Engine Room, with the large Alternator in the foreground.

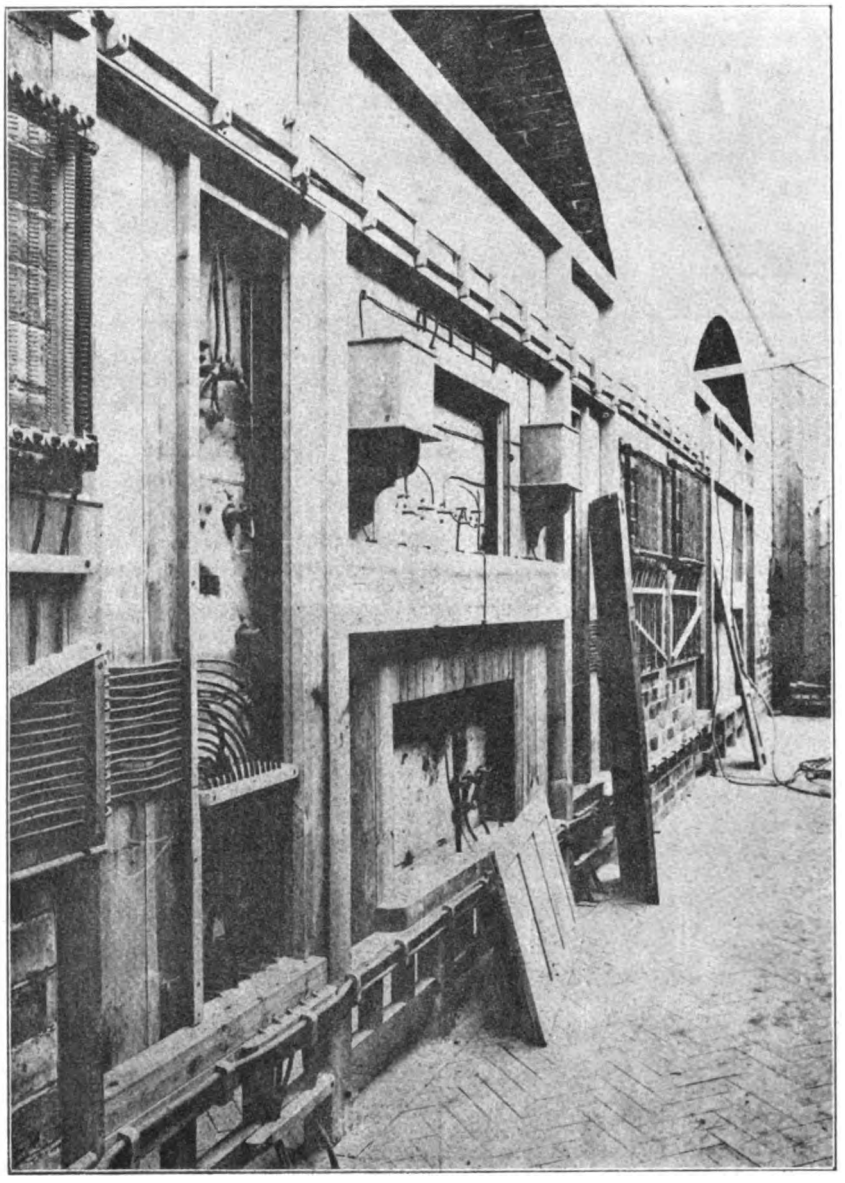

FIG. 5.—Gallery behind the Switchboard, showing the wood covers removed.

one common shaft can be used for the boilers and destructors; (*d*) the two, or in this case three, operations under the engineer's charge can be placed close together, hence saving time in supervision.

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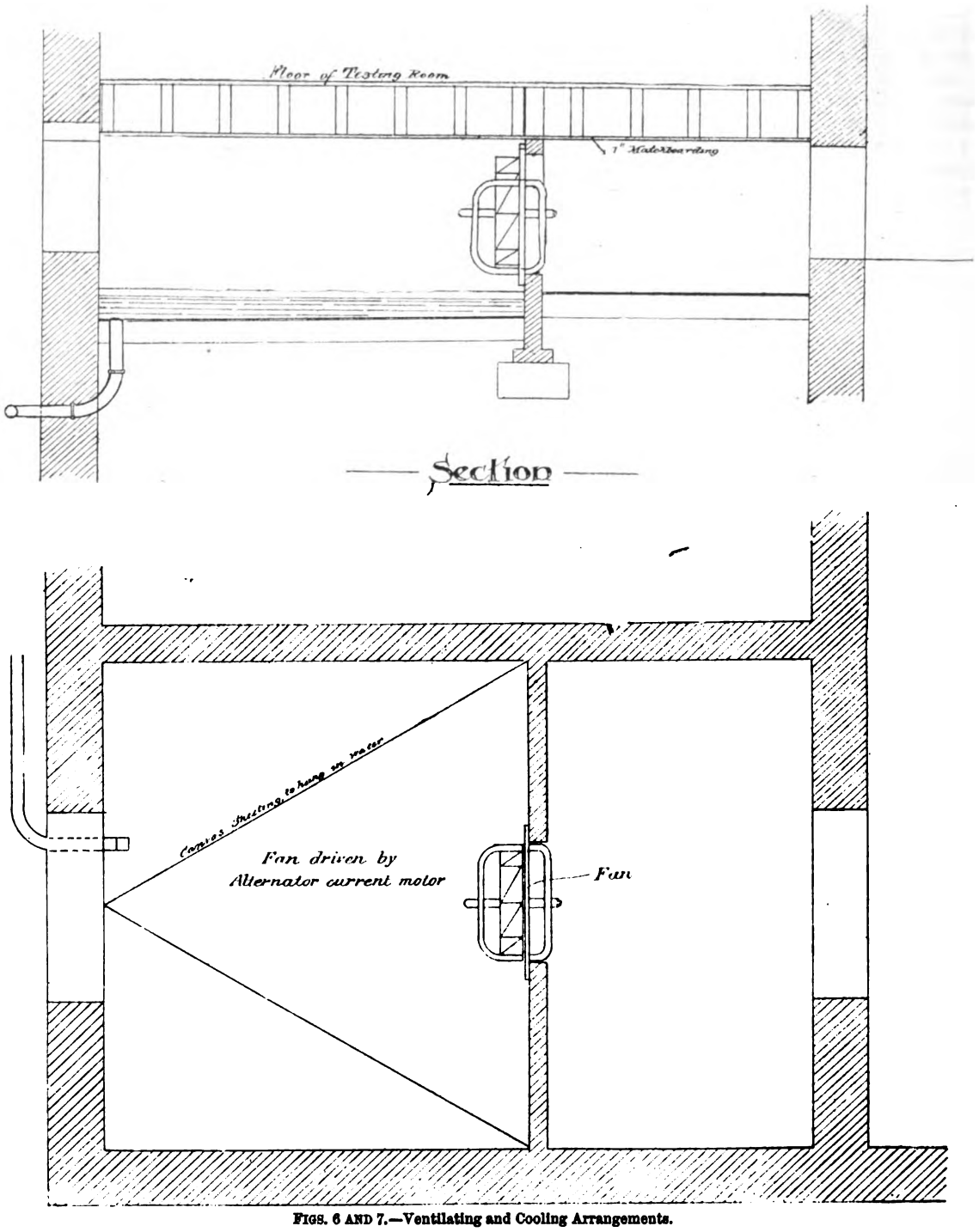
The other operation referred to is the manufacture of manure in the building just showing between the destructor, on the left-hand side of Fig. 2, and the electric lighting station on the right. The fine ashes falling through the fire-bars of the destructor are mixed with the deodorised sludge from the sewage outfalls. In this way a manure is made which commands a ready sale.

The system of charges has been carefully gone into, as will be seen by the following extract from the "condition of supply" fixed on a liberal and fair basis by Mr. Hall.

The price of electrical energy will be 6d. per Board of Trade unit. (At 6d. per Board of Trade unit an 8-c.p. lamp costs about one-fifth of a penny per hour, and a 16-c.p. lamp about one-third of a penny per hour.) Customers' accounts will be made up quarterly, and payments must be made at the Municipal Offices; 5 per cent. discount for cash will be allowed on accounts paid within 21 days, and in case of non-payment within 28 days the Corporation may refuse to continue the supply. At the end of every municipal financial year, which is on March 25, the total bill of every customer will be credited with rebates on a scale of which the following are examples, intermediate values being in proportion.

Greatest rate of consumption of energy in watts.	Rebate in proportion to the number of Board of Trade units taken during the year.							
	2½	7½	12½	17½	22½	27½	32½	37½
100	45	60	75	90	105	120	135	150
500	225	300	375	450	525	600	675	750
1,000	450	600	750	900	1,050	1,200	1,350	1 500
2,000	900	1,200	1,500	1,800	2.100	2,400	2,700	3,000
5,000	2,250	3,000	3,750	4,500	5,250	6,000	6,750	7,500
10,000	4,500	6,000	7,500	9,000	10,500	12,000	13,500	15,000

Take for an example the consumer whose maximum load is 1,000 watts. If he has his full load on for some 1,050 hours he gets a total allowance of 22½ per cent. plus 5 per cent. for cash, which will reduce the charge from 6d. to 4·35d. per unit. Again, should he use his lights for 1,500 hours he will get 42·5 per cent. rebate, only paying 3½d. per unit. (That some consumers use as much as this would not be very extraordinary.) If he used his full load from sunset up to 10 p.m., that would account for 1,456 hours, and even with 1,500 hours' lighting the load-factor would only be 17 per cent., whereas we know of at least two places in London where



FIGS. 6 AND 7.—Ventilating and Cooling Arrangements.

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the load-factor is over 20 per cent. In this scale of rebates the Corporation give the light on the best terms to its most paying consumers, but the rate may tend to keep down the total number of lamps installed. We do not doubt, however, that it will stimulate the increase of the total units supplied. As a concession to small consumers, Mr. Hall has induced his committee to give up the customary meter rents. This charge for meters would hardly be felt by large consumers, but in small office installations it often exceeds the charge for current.

We believe, from local evidence, that the light is being well taken up in Cheltenham. The supply was commenced early in April, and in the experimental period, lasting till May, no charge was made for light. The liberal inducements held out to consumers should ensure a speedy increase in the power required. We shall not be surprised to hear next November that new machinery in larger units is required to supply the winter load. We understand that the total cost of the whole of the plant will come just within the £16,000 borrowed.

The electric lighting works were handed over to the Electric Lighting Committee by the contractors on Thursday, May 16. In commemoration of the completion of the station, the chairman and members of the committee entertained a large representative company to dinner at the Plough Hotel, Cheltenham, in the evening.

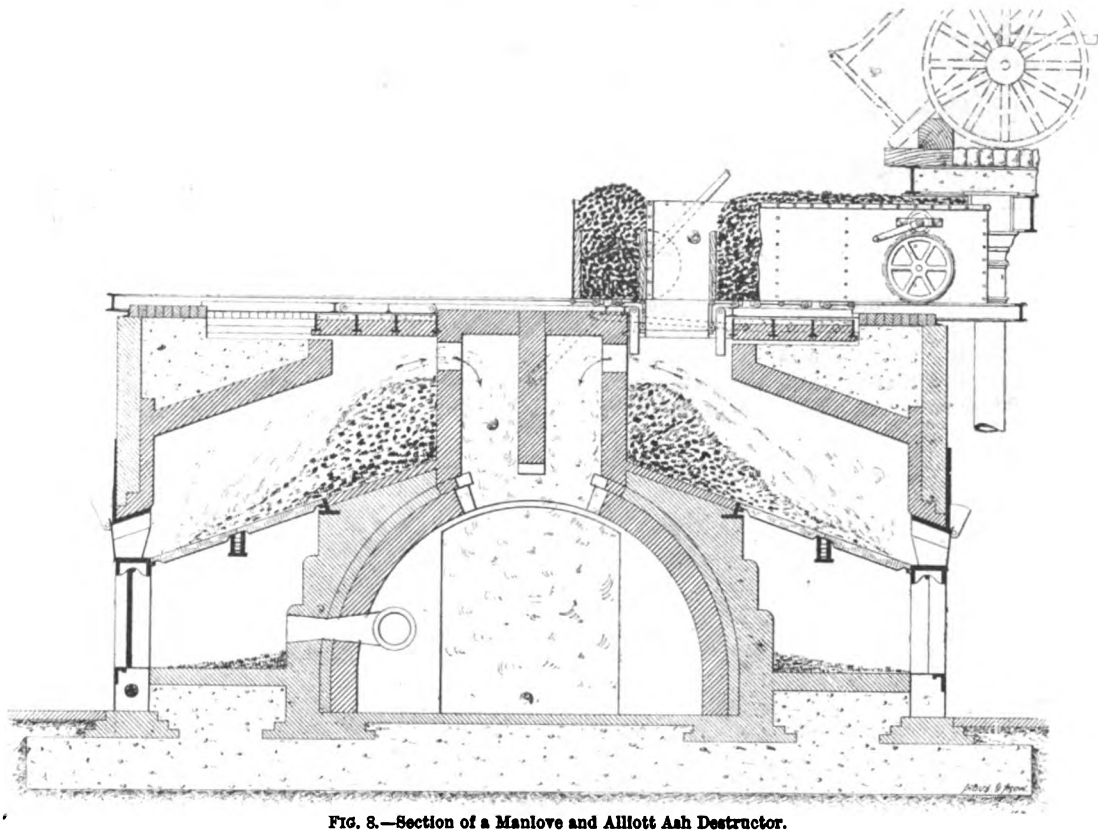

FIG. 8.—Section of a Manlove and Alliott Ash Destructor.

Buildings.

The whole of the designs for the buildings were prepared by Mr. Hall. There is no attempt made to attain external artistic beauty, but the general appearance is neat. The internal arrangements have been constructed with reference to practical requirements only, and no expense has been spared in the serviceable details, but the final ornamentation of the walls by panelling, etc., will not be carried out at present. The building contract was given to Messrs. Malvern and Son, of Cheltenham. The foundations, as will be seen by Fig. 3, had to be carried down some 16ft. to get on to firm soil.

General Description of the Works.

As previously stated, the central station stands on surplus land of the site (Fig. 1) acquired by the Corporation for the erection of the refuse destructor. It adjoins the Midland Railway Company's line near High-street, with which it will be ultimately connected by a siding. On approaching the works (Fig. 3) from Arle-road, the first points that strike the observer are that architectural effect was not one of the aims of the designer, and that there is no chimney-stack in immediate connection with the building. This latter point is explained by the fact that the boiler flues are led into the destructor chimney, the existence of which was one of the economic reasons which decided the adoption of the site. The chimney is about 70ft. distant from the south side of the building, and the furnaces are connected with it by means of an underground flue some 4ft. 6in. by 4ft. in section. The boiler-house is open on two sides, on the one side ample room being left for all probable extension. Two Galloway boilers are at present fixed, the working pressure of the steam being 120lb. to the square inch. In addition to these two, there is the boiler in the destructor, which it is estimated will yield 50 h.p. or 60 h.p. from the heat of the refuse furnaces—a source of energy otherwise wasted. The steam from this boiler, as well as from the two in the boiler-house, is led into a main ring of 6in. diameter, from which the steam is again distributed to the engines. A door by the boiler-house leads into the main passage 40ft. long, from which the workshop, store-room, and general office open on the right, and at the opposite end the engine-room; the flue, on its way from the boilers to the chimney, passes under the floor of this passage.

The engine-room is a lofty room, 25ft. wide, with a present length of about 60ft. As in the boiler-house, so here provision has been made for unlimited extension towards the west side of the building—a temporary match-board partition closing the end. The floor of the engine-room is of wood paving on concrete. There is a platform 3ft. wide and 3ft. high along two sides of the room from which the operations may be overlooked. On entering, one faces the condensing plant (by Belliss and Co.). This plant is sufficient for condensing the steam from the three engines at present in position. Well water, of which a good supply is found on the site, is used for condensing purposes, but there is also connection with the river-water main, from which the boilers are supplied. All the engines exhaust into one large main. Should the condensation not be sufficient from any cause to deal with this exhaust, an automatic valve, designed by Mr. Kilgour, is opened by the excess pressure, and allows the steam to exhaust into the open.

The engines are of the well-known Willans high-speed

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type, the large set being of the I I type, and the two smaller sets of the G G type. They are direct coupled on common bedplates to Siemens alternators by means of buffer spring couplings, Fig. 11. The foundations for the whole building and for the machines have had to be carried down some 16ft. through sand and gravel into the clay bed. The exciters are placed on the same shaft as the alternators, the armatures being of the over-hung type, requiring no outside bearing. These exciters are series wound, and are said to afford means of regulating easily the station voltage from the normal 2,000 volts up to as much as 2,500 volts.

in the recess formed by the driving platform, which runs the full length of the engine-room.

The switch panels, of which there are six at present, are supported in the arches on the north side of the building. A lean-to gallery, 5ft. wide, is constructed on that side of the building, which affords easy and convenient access to the connections (Fig. 5). In their endeavour to procure absolute safety, the designers of this station have, we consider, erred on the careful side. They have boxed the back connections in with wood panels, which, although easily taken down, prevent the ready inspection of these parts

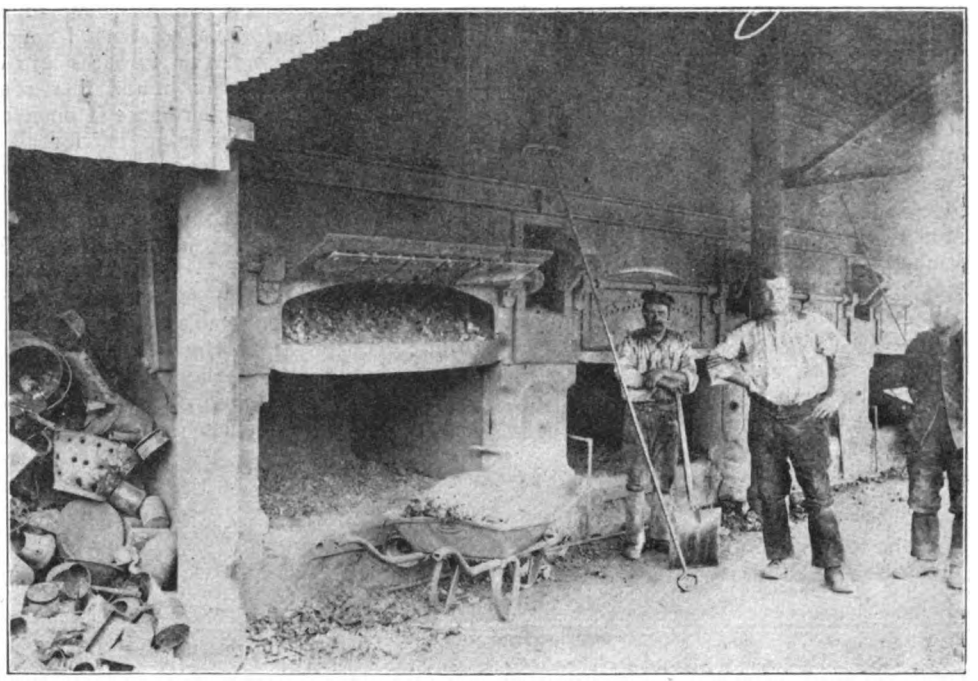

FIG. 8A.—View of Refuse Destructor at Cheltenham.

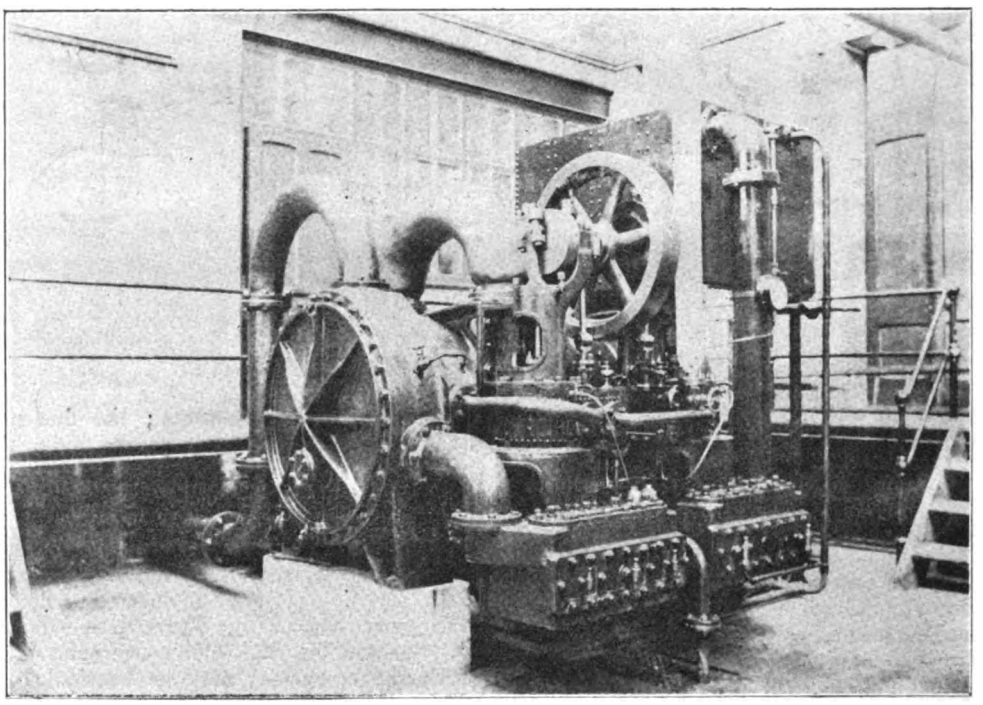

FIG. 9.—Bellias Condensing Plant and Feed Pumps.

The general arrangement of the machinery in the engine and boiler rooms will be seen from the plan and elevation, Fig. 3, and from Fig. 4, which was taken from the west corner of the engine-room. The steam and exhaust pipes are not shown in these views, but the steam-pipes are supported overhead in such a way as to allow for expansion. The exhaust pipe is placed on the floor, and is laid also, in case of a fault occurring, the wood would be ignited by the arc, and then to remove the panels will be a dangerous operation. We do not approve of making the back of a switchboard too inaccessible or safe, as such precautions breed carelessness in the attendants.

For cooling and ventilating the engine-room, Mr. Hall has devised a method illustrated in Figs. 6 and 7. The air

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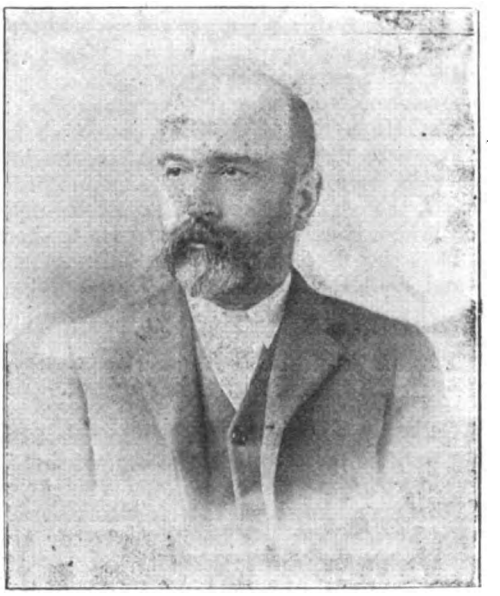
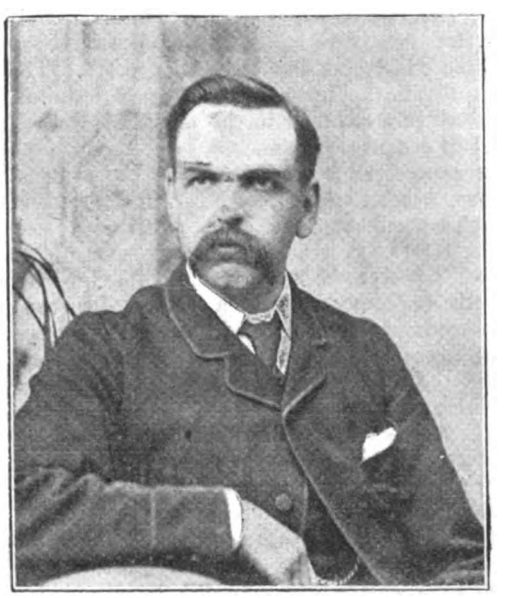
ALDERMAN WETHERED, F.G.S., F.C.S.,
Mayor of Cheltenham.



ALDERMAN NORMAN,
Chairman of the Cheltenham Electric Lighting Committee.

CHELTENHAM PROMENADE

MR. M. H. KILGOUR, A.I.E.E.,
Borough [Electrical Engineer.]



MR. JOSEPH HALL, A.M.I.C.E.,
Borough Surveyor and Engineer, Designer of the Cheltenham Electric Lighting Station

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is forced by means of a fan driven by an alternate-current motor through a canvas screen, kept moist by dipping in water. The apparatus is not yet at work, but the engine-room has a north aspect, and does not get unduly hot under the present working conditions.

The seven-ton overhead travelling crane was constructed by Messrs. Humpidge, Holborow, and Co., Limited, of Dudbridge, Stroud. It is of 25ft. span, the height from floor to rails being 19ft. 2in. The main girders are of steel joists, the end carriages of steel channels bolted to cast-iron bridge pieces. All motions are worked by hand chains from the floor below. The hoisting motion is of single and double purchase, fitted with brake and pawl gear for lowering purposes, and is capable of being operated by one man.

Steam Generating Plant.

Two Galloway boilers are provided, each 24ft. long by 7ft. diameter. They are capable of evaporating 5,000lb. of water per hour, with average coal and draught, which will drive 250 indicated horse, with an engine consuming 20lb. of water per horse-power per hour; and they are suitable for 120lb working pressure, the shell plates being $\frac{5}{8}$in. thick. The shells are 24ft. long by 7ft. diameter, and the longitudinal seams are butt-jointed with inside and outside cover strips secured by four rows of rivets. The interior consists of two furnaces joining into one Galloway flue. The furnaces are 2ft. 9$\frac{1}{2}$in. in diameter, solid welded longitudinally and flanged transversely by machine. They are united behind the fire bridges into one flue. The flues are supported by 28 Galloway cone tubes, all interchangeable, and with the flanges square to the centre line of tube, thus putting less strain upon the material during manufacture. Four patent pockets are fixed in the flue to divert the flame amongst the cone tubes, also two patent expansion pockets at the back end to prevent the undue escape of the heated gases, and to give the necessary space in the end plate for expansion and contraction. The furnaces and flue are provided with solid-welded angle rings for attachment to the ends. The boiler ends are solid, rolled in one piece $\frac{5}{8}$in. thick. The feed-valve is 2$\frac{1}{2}$in., the valve loose from the spindle so as to act as a check or non return valve, and to be set down by means of a hand-wheel and screw, also a connecting T-piece outside and perforated pipe inside the boiler for effectual distribution of the water. The safety-valves are one 4in. knife-edge lever safety-valve, with graduated lever and weight, and one lock-up spring safety-valve. The steam junction valve is 6in. (branch pattern), fitted with gunmetal valve and seating.

Fryer's Ash Destructor.

The other source of steam power is the ash destructor, which is explained above, and is placed in a building near the electric lighting station. These destructors were made by Manlove, Alliott, and Co., of Nottingham, and have been in use for some years. The steam up to the present has been used chiefly for disinfecting purposes. The whole of the linen from the fever and small-pox hospital has been disinfected in a chamber in the chemical works (shown in Fig. 2) by means of steam.

The general construction of the Fryer cells made by Manlove, Alliott, and Co. is shown in Fig. 8, but the Fryer cells at Cheltenham have been constructed side by side. Each cell forms a separate furnace, comprising a cavity enclosed by a reverberatory arch lined with firebricks. The cell is provided with a hearth for the reception of the refuse to be burned, from which it passes into the furnace proper. The passage of the material to the front is facilitated by arranging the fire-bars in an inclined position, which also renders easy the removal of the clinkers. The top of the destructor constitutes a platform, an opening over each cell being provided for the reception of the mixture of sludge and ashbin refuse, which is shot through the opening direct from the dust-carts. It will, of course, be understood that the opening for the admission of refuse is divided from that for the exit of gases, the division being formed by a wall, whilst a bridge is provided to prevent the refuse heaped on at each charge from getting into the flue immediately below. Special openings are provided for the direct introduction upon the burning mass of infectious mattresses, diseased meat, dead cats and dogs, etc. The furnaces when once lighted are kept at work by the refuse itself. In order to prevent inconvenience to the stokers through the fine dust being blown about, a concave pit is constructed under the furnace bars. This pit is partly filled with water, and the fine dust falling therein is removed when the fires are drawn. The clinkering is done at intervals of about two hours, and the quantities of clinker and fine ash vary in proportion to the kind of material burned. The clinker is used in the manufacture of concrete, for tar paving, for building, and path making purposes, hard core for roads, artificial stone when ground up as sand, and for the construction of walls. There are eight of these cells at Cheltenham, and a cremator.

Condensing and Feeding Plant.

These parts of the machinery were supplied by Messrs. G. E. Belliss and Co., of Birmingham. The condensing gear is shown in Fig. 9. This plant includes, besides double-acting circulating and air pumps, a double-acting feed-pump, worked by an eccentric on the crankshaft. The water passes twice through the condenser tubes, the steam being outside them. The condensed steam is discharged by the air-pump into the hot-well placed above the level of the condenser. In the hot-well is arranged an apparatus for removing the grease from the feed water. The following are a few of the leading dimensions of this plant:

Diameter of high-pressure cylinder	6in.
,, low ,, ,,	10$\frac{1}{2}$in.
Length of stroke	6in.
Diameter of double-acting air-pump	12in.
,, ,, ,, circulating-pump	12in.
Cooling surface	700 sq. ft.
Diameter of feed-pump	2$\frac{1}{4}$in
Length of stroke	7in.

In the boiler-room an additional feed-pump is provided as a stand-by. It is of the Worthington type, but was supplied by Belliss and Co. No economiser has been fixed as yet, but the necessary flue accommodation has been provided, so that one can easily be installed. The feed-pipes are in most cases duplicated, and so supplied with valves that no single fracture would necessitate shutting down for want of steam.

Steam and Exhaust Pipes.

The whole of these have been erected by the Corporation engineer, the execution of the work being under the supervision of Mr. Kilgour. The main steam-pipe is constructed on the ring principle, but a new departure has been made in placing that part of the ring usually placed in the engine-room in the space over the economiser flues. The reason for this arrangement is a wish on the part of Mr. Hall to have as few steam joints in the engine-room as possible. This is an advantage in many ways, but any defective joint will hardly be as quickly noticed in the unused space between the boiler and engine rooms (Fig. 3) as if the steam-pipes were in the engine-room itself. With frequent inspection, however, any defects should be noticed before they become serious. Hopkinson's straight-through parallel slide-valves are used throughout, and placed in such positions that the possibility of a failure of light through a defective steam-pipe is minimised. All the joints are made with asbestos sectional packing. The whole ring main is suspended from brackets fixed in the walls by means of attachments allowing lateral movement in either direction. In this way the need of expansion joints is largely overcome. The steam-ring is drained by steam-traps, and one of Geipel's steam-traps is also connected to each engine steam-separator. The exhaust-pipe is laid on the floor, as explained in the general arrangement of plant. In the main pipe there is placed an automatic valve, designed by the electrical engineer, for opening the exhaust system to the air should the pressure in it rise above that of the atmosphere: a section of this is shown in Fig. 10.

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A is a gunmetal bush screwed inside and made square outside, and capable of sliding in the outer bush, which is held in position by the two studs at the top. G is the gunmetal valve spindle. O is the outlet, the inlet being at

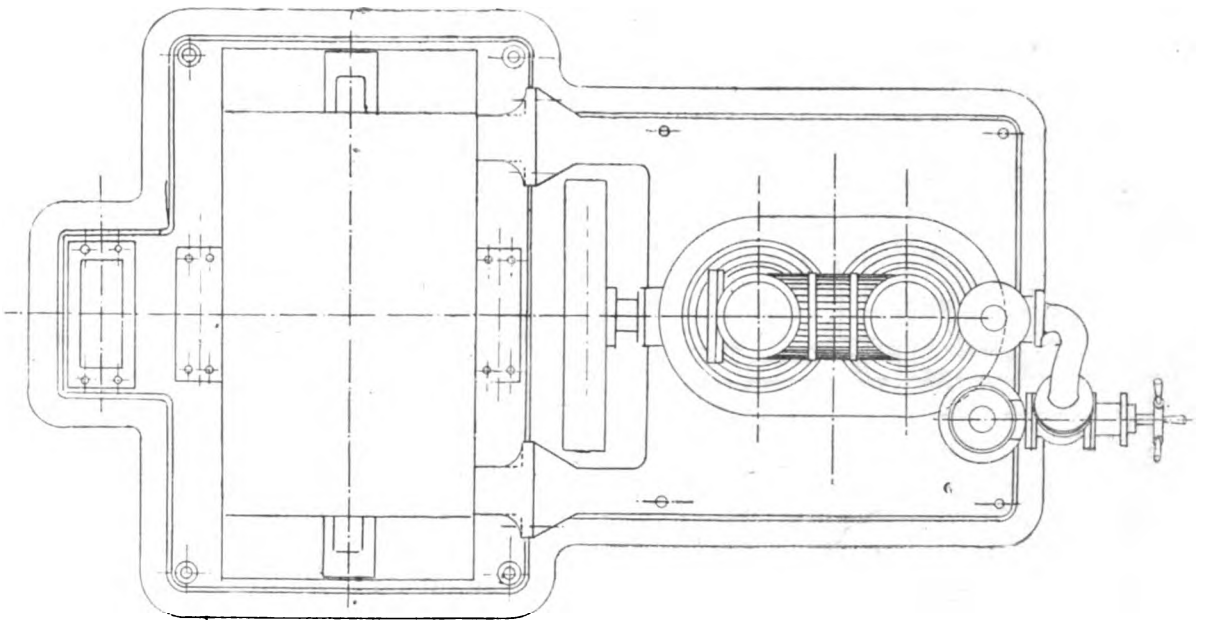

FIG. 12.—Plan of 33-K.W. Steam Alternator.

the underside of the valve. The principle of the valve is apparent from the illustration. Should the pressure in the exhaust-pipe exceed that of the atmosphere the valve rises, the square bush sliding inside the outer brass bush; the valve can also be opened by hand by means of the milled wheel, W.

The Engines.

These are of the well-known Willans central-valve gear type. There are three of these engines at Cheltenham—one of the I I size, capable of giving 200 i.h.p. at 350 revolutions per minute; and two of the G G size, capable of giving 80 i.h.p. each at 460 revolutions. The steam pressure under which the first works is 105lb., while the remaining two are supplied at 65lb. per square inch. All three engines are coupled direct to Siemens alternators. The cylinders of the I I engine are 20in. and 14in. in diameter, and its stroke is 9in., while those of the G G engines are 14in. and 10in in diameter, and the stroke is 6in.

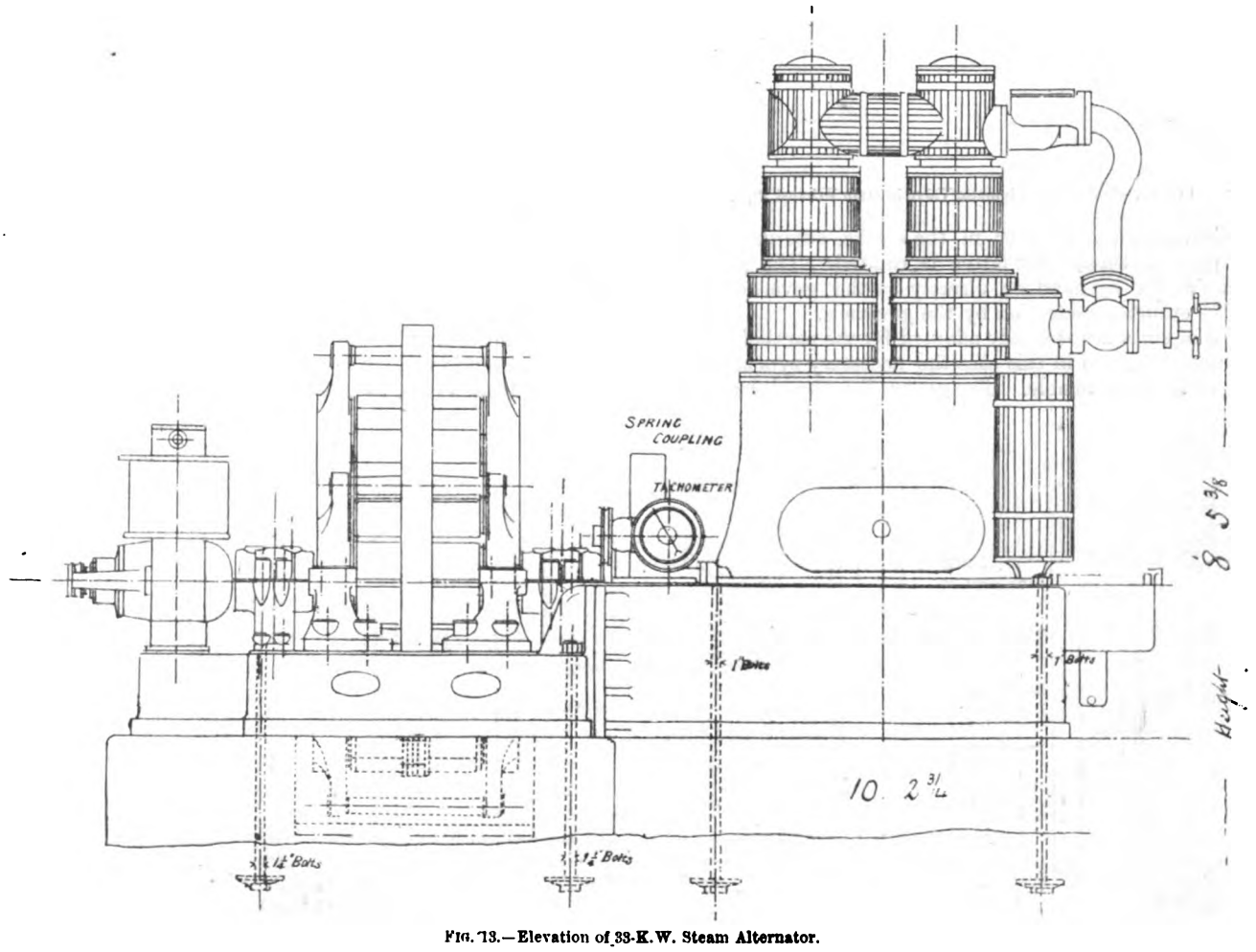

FIG. 13.—Elevation of 33-K.W. Steam Alternator.

The variable expansion gear is arranged as follows: The steam gland in the high-pressure cylinder is made movable and takes the form of a sleeve with oblique ports cut in it. There are corresponding ports in the hollow piston-rod,

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Cut-off is effected in the manner usually adopted in these engines—by the passage of the ports in the hollow piston-rod into the gland out of the steam-chest. The point of cut-off is varied by rotating the gland sleeve upon its axis, the ports in the piston-rod meeting the edges of those in

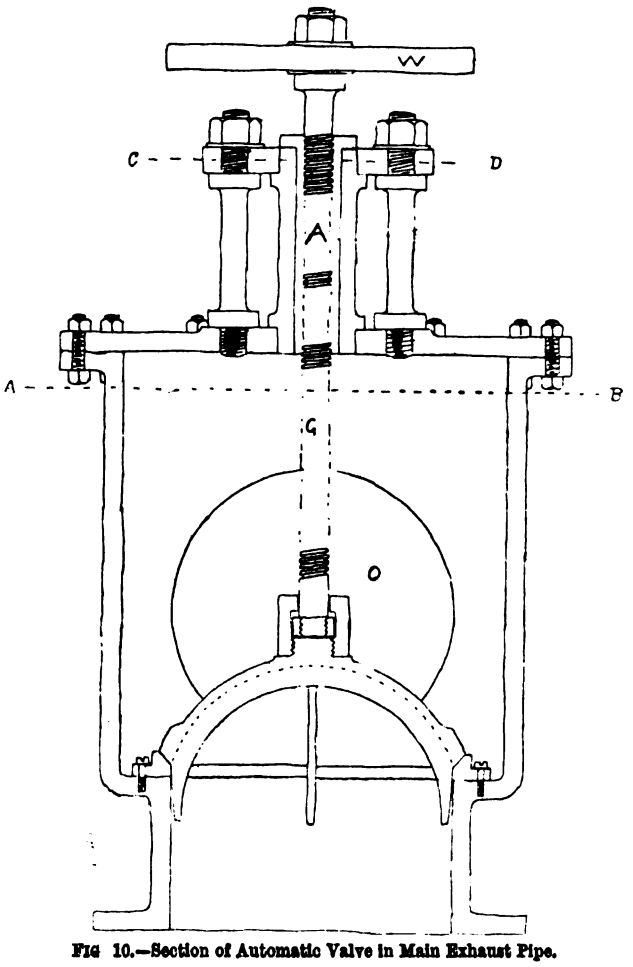

FIG 10.—Section of Automatic Valve in Main Exhaust Pipe.

the sleeve earlier or later in the stroke, according to the direction in which the latter is rotated. The sleeve is moved either by hand or directly by the governor, or by a relay cylinder controlled by the governor.

The engines are specially adapted for the parallel running of alternators, and in this case the necessary synchronising current is inappreciable. The reason for the difference in the specified steam pressure in the two sets is as follows: The smaller engines have to be sufficiently large to develop the power required for driving the small alternators when the steam pressure is not less than 65lb. above atmosphere and the back pressure not more than 6lb. absolute. The large engine need only be large enough to develop its rated power with a pressure of not less than 105lb. above atmosphere and a back pressure of not more than 6lb. absolute. All engines are made strong enough for a working steam pressure of 130lb. to 140lb. above atmosphere in their steam-chests. The reason of this curious diversity between the engines is very simple:

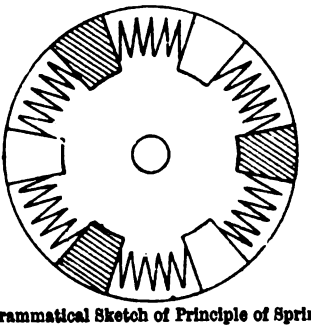

FIG. 11.—Diagrammatical Sketch of Principle of Spring Couplin .

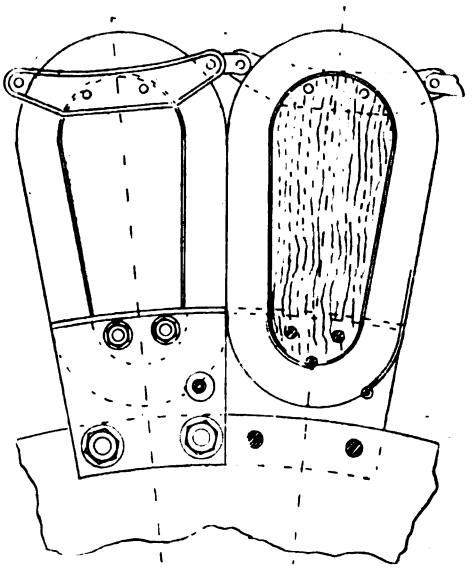

FIG. 15.—Coils of a Siemens Alternator.

the small engines are about as much as the ash destructors are able to supply steam to, and the cylinders, therefore, have to be large enough to develop the power required with the pressure available from the ash-destructor boiler, which is 80lb. at most, or, allowing a margin, 65lb. at the engines. The large engine will always be worked from Galloway boilers, at from 115lb. to 120lb. pressure, because when it is worth while to run this engine the load will be too much for the ash-destructor boiler. All the engines will be worked from the Galloway boilers when the load is above 100 kilowatts. Mr. Kilgour estimates from some rough tests already made that the destructor boiler will evaporate about 1,000lb. of water per hour, and thus is capable of driving one of the 33-kilowatt sets.

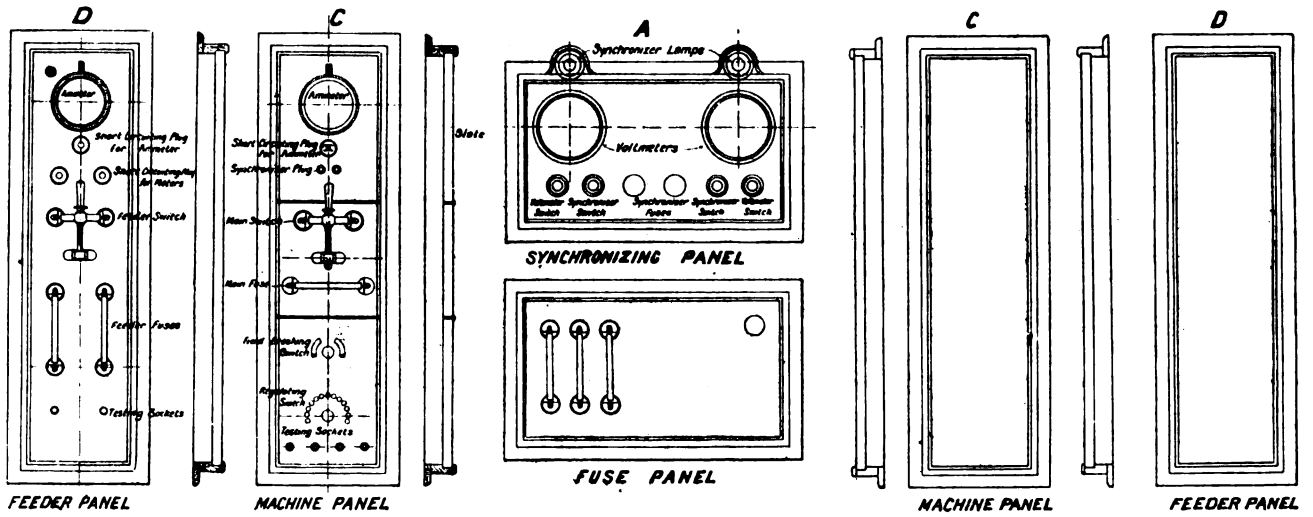

FIG. 16.—View of the Cheltenham Switchboards.

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Alternators.

These are of the now well-known type manufactured by Messrs. Siemens and Co., of Woolwich. The larger alternator is designated by the mysterious symbol "W 32," which is compiled from the fact that W stands for alternator in German, and 32 is the number of poles. This machine gives 50 amperes at 2,200 volts when running at a speed of 350 revolutions, the frequency thus being 94 ⁓ per second. The smaller alternators are "W 24"'s, having 24 poles, and giving 33 kilowatts at a speed of 466 revolutions per minute. They are direct driven by the engines by means of a specially designed spring coupling. The details of this coupling, which have been of great assistance in other stations where there has been trouble with parallel running, are not available, but we understand that the general principle of the coupling is as follows: Two similar claw castings are provided, one attached to the engine shaft and one to the dynamo shaft, Fig. 11. Spiral springs are placed between the alternators' claws, and in this way a sensibly flexible drive is obtained.

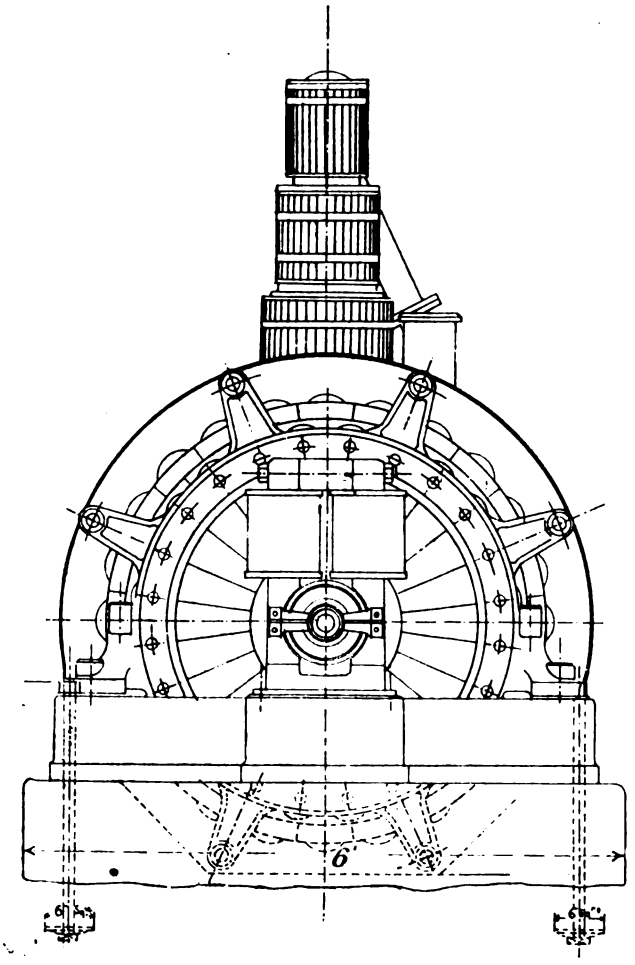

FIG. 14.—Side Elevation of 33-K.W. Steam Alternator.

The effect of this coupling, together with the steady running of the Willans engine, allows of parallel running without any sensible fluctuation of current.

The construction of the small alternators can be seen from Figs. 12, 13, and 14, the 110-kilowatt machine being of the same general type. The armature coils are wound on wooden formers, as shown in Fig. 15, and are composed of fine-stranded copper wire pressed into a rectangular form, after the usual method adopted by Messrs. Siemens and Co.

The mounting of the coil on to the wrought-iron disc which acts as the armature hub is effected in the manner shown in our diagrammatic sketch. The magnets are of wrought iron, and are mounted in cast-iron yokes, as shown in the general arrangements (Fig. 4), and the magnetising coils are connected to give alternately north and south poles. The usual Siemens collecting gear is used. The bearings are of special construction, with efficient lubrication. The larger steam dynamo is guaranteed to deliver, working at not less than three-quarters full load, not less than 560 watts per indicated horse-power, and each of the two smaller steam dynamos under the same conditions not less than 500 watts per indicated horse-power. Also, under the foregoing conditions of load, and with a steam pressure of about 130lb. per square inch (absolute) in the steam-pipe, and a back pressure not exceeding 6lb. per square inch (absolute) in the exhaust-pipe, the consumption of steam per indicated horse-power per hour is not to exceed 20lb. for the larger and 23lb. for each of the two smaller steam dynamos. The exciters are all of equal output, and are Siemens's "H D 10 6½" series dynamos. These are constructed on the overhanging principle, to avoid the necessity of a third bearing. The armature is attached to the extension of the alternator shaft. With constant-speed machines the series excitation allows of more ready regulation, although the resistance provided for regulating purposes has to be of a much larger section than when the exciters are regulated on the shunt system.

Switch Gear.

The switchboards have been made by Messrs. Siemens Bros. (Fig. 16). Six panels have been supplied up to the present, consisting of two machine panels, two feeder panels, a fuse panel, and a synchronising panel. The connections are those usually adopted for parallel running. The high-tension switches and fuses are all of the Siemens approved type, and the men are liberally protected against accidental contact with the live metal.

Distribution.

The distribution is on the high-tension sub-station system, but in some cases transformers have been placed temporarily on the consumers' premises. All the mains in use at Cheltenham, both for the high-pressure feeders and the low-pressure distribution network, have been manufactured and laid by the Callender's Bitumen Telegraph and Waterproof Company, Limited, whose resident engineer on the work was Mr. G. Barnard.

FIG. 17.—Laying Mains at Cheltenham.

The main high-tension cable is capable of transmitting 350 h.p., or of lighting, say, 8,500 8-c.p. lamps. It is drawn into paper tubes, of the Hawtayne system, embedded in a layer of bitumen, which, in its turn, is laid in Portland cement concrete—this can be seen in Fig. 17. The high-tension mains runs along High-street and St. George's-place to the chief distributing station, at the corner of Manchester-street, opposite the free library. Hence the current is distributed to the various underground sub-stations throughout the town, where the high pressure of 2,000 volts is reduced to 100 volts. A system of low-tension mains is laid from these sub-stations wherever the demand warrant the necessary expense. In other places, as in a division of the High-street, between New-street and Clarence-street, with St. George's-place, the consumers are supplied by a high-pressure main, with transformers on their own premises. Of the five or six sub-stations contemplated three are now practically complete, these being situated in High-street opposite North-street at Cambray, and at Ormond-place.

(*Continued on page 566*)

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TO CORRESPONDENTS.

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DUBLIN TRAMWAYS.

We have before us a copy of the report which Mr. Robert Hammond has submitted to the directors of the Dublin United Tramways Company with reference to the proposed introduction of electric traction upon its lines. After a short comparison of the three available mechanical systems of traction — steam, cable, and electricity—Mr. Hammond concludes that, so far as Dublin is concerned, the only advisable method of operation is by electricity, and that of electrical systems the only commendable one is that which employs elevated conductors and trolleys. Mr. Hammond conclusively demonstrates that no danger can result from the use of elevated conductors and a potential of five hundred volts, supporting this conclusion by quotations from high American authority and by the statements of local authorities of the district served by the South Staffordshire tramways. An interesting statement is that made by Mr. Clifford, manager of the Law Accident and Contingency Society, to the effect that when the South Staffordshire tramway was first insured against "third party risks," the same rates were charged as are usual for the insurance of steam tramway companies, but that owing to immunity from accidents the premium had been diminished, till it is now less than half the steam tramway rate. This testimony is most convincing. The report then proceeds to enumerate various objections which have been raised to the overhead conductor and trolley system, mainly with reference to the unsightliness of span wires in the public streets. This line of objection is disposed of by Mr. Hammond by reference to the system now employed by the South Staffordshire tramways, which were constructed by the Electric Construction Corporation, Limited, and which system of line construction is also in course of installation at Bristol by the British Thomson-Houston, Limited. This method of construction, in which the trolley wires are supported at a considerable distance from the track from brackets attached to poles along one side only of the roadway, is accepted by Mr. Hammond as the best, principally for the reason that it interferes less with the progress of fire-escapes along the street than might be the case where span wires crossing the street at intervals are employed.

On this point we take issue with Mr. Hammond, and it would seem to us that he proposes the adoption of the less efficient method of line installation as the easiest way out of a difficulty with local authorities. There certainly is no reason why an existing type of fire-ladder should be perpetuated indefinitely and always remain of a given height, when it would be the simplest of mechanical expedients to decrease the height of the permanently standing portion of the ladder to such an extent as would enable it to pass easily under wires twenty-one feet above the roadway. We might go further and say that these extremely cumbersome fire-escapes are wholly out of date, and that instead of sacrificing the cross-suspension method in order to facilitate their passage, it would be far more advantageous to both fire department and tramway company

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to introduce the horizontal ladders nearly universally used both in America and on the Continent. If American and European practice in electric traction has demonstrated anything, it has conclusively proved that economical and efficient operation can best be secured by a trolley wire over the centre of the car roof, and that every departure therefrom is necessarily accompanied by increase in cost of maintenance and decrease in the efficiency of the service. Many thousands of miles of track and some thirty-five thousand motor cars are now successfully operated under these conditions, while operation by a side wire and a side-acting trolley has the support of but one single instance, and that a line constructed under the necessity of complying with special local conditions. We would, moreover, call attention to the eminent danger of experimenting on the tramways of a great city with data obtained from a small country installation, when these results are distinctly at variance with those obtained on all the great electrical tramway installations which are now in use. In the South Staffordshire tramway equipment a specific difficulty was ingeniously overcome, but it would seem unwise to suggest that such an expedient, however ingenious, should be followed where the necessity for its introduction is not apparent. It is our opinion that wherever a line of track does not run close along the kerb line, the span wire supporting the trolley wire centrally over the car is vastly preferable to such construction both in appearance and in certainty and economy of service. Where, as in many continental installations, the span wires can be supported by rosettes attached to the walls of buildings along the route, all reasonable objection to them entirely disappears. Of all methods of supporting the trolley wires for a double-track tramway in broad streets, the centre pole between tracks is by far the most satisfactory from every point of view.

There is another point on which we do not quite agree with Mr. Hammond. He states that "the problem of generating electricity for lighting and for traction are almost identical." In this we certainly do not concur, and we think that all those having experience in electric traction will agree with us when we say that to design an electric tramway power-house on the same lines as would be followed were an electric lighting station in question, would prove financially disastrous. The choice of units, type of dynamos, engines, boilers, and arrangement is very different in a traction plant to what it would be in a lighting station. This experience has been bought and dearly paid for in America as well as on the Continent, and it is to be hoped that English tramways desiring to substitute electric traction for other motive power will profit by the experience that is at hand, and not insist upon paying a heavy price for original and individual experimentation. We wholly agree with the closing paragraph of Mr. Hammond's report, in which he says that from the point of view of the citizens, the corporation, and the tramways the introduction of electric traction into Dublin is most desirable. We will go further and say that the introduction of this mode of traction is desirable in every English town, and we look forward to a day not far distant when tramways equipped with the most modern mechanical power will relieve the crowded thoroughfares of the Metropolis itself.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CITY AND GUILDS EXAMINATION.

SIR,—Notwithstanding your note to the contrary, I still think this question (No. 6) has not been answered correctly. Mr. Shepherd says the mean current along the line is 100 amperes. May I ask why? The question says plainly that one ampere is required for every 10ft. of frontage, and as there are 2,000ft. frontage, 200 amperes are required. I think, also, you were in error in saying that Mr. Shepherd's answer would have taken full marks. It certainly would not, as the working by which he gets the current is not shown, nor the reasoning by which he arrives at ·02 as the resistance of the circuit. This would certainly be marked "deficient." I append a solution I posted last week in Edinburgh, but which I presume has not reached you or has been mislaid:

(*a*) Current required $= \frac{2,000}{10} = 200$ amperes.

Total resistance between first and last lamp $= \frac{\text{fall in volts}}{\text{current}} = \frac{2}{200} = \cdot 01$ ohm.

But the resistance of a bar of copper 2,000ft. long 1 square inch section = ·008 × 2 = ·016 ohm.

·01 ohm : ·016 ohm :: 1 square inch : x square inch,

$\therefore x = 1{\cdot}6$ square inches. —*Answer.*

(*b*) The supply is now midway and the distance between the first and last lamp is 1,000ft.

$\therefore$ Current required is $\frac{1,000}{10} = 100$ amperes.

As before, resistance $= \frac{\text{potential difference}}{\text{current}} = \frac{2}{100} = \cdot 02$ ohm,

and the resistance of 1,000ft. of copper bar 1 square inch = ·008 ohm,

$\therefore$ ·02 : ·008 :: 1 square inch : x square inch,

$\therefore x = \frac{\cdot 008}{\cdot 02} = \cdot 4$ square inch.

There is no mention of a return wire in the question, and we have no right to assume one. The return may be "earth."—Yours, etc., JAMES MCLURE.

29, Stirling-street, Airdrie, N.B., May 12, 1895.

SIR,—The reason I took the total instead of the mean current was that in the question no reference is made as to the distribution of the current along the mains. It says, "Current is required along a street 2,000ft. long at the *rate* of one ampere per 10ft. of frontage." Should the bulk of the lamps be alight at the far end of the mains while only one or two are alight at the station end, then my calculation would practically apply.—Yours, etc.,

HALDANE G. COTSWORTH.

14, Station-road, Swindon, May 15, 1895.

FIRE RULES.

SIR,—As certain statements have been made with regard to electrical installations placed up in consumers' premises that may give rise to erroneous impressions and cause needless alarm, I beg you will be courteous enough to spare me a portion of the valuable space in your columns to enable me to say a few words upon the subject.

So far from electrical installations being now placed up in buildings in a worse manner than formerly, my experience is that every year shows an improvement in the way the work is done; and that, taking electrical installations as a

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whole, the work is better put up now than it has ever been. So far as I can learn, there is no country in the world where the installations inside buildings are to be compared to those installed in England.

With regard to fire danger, I have to say that the Phœnix Fire Office has not yet had to pay a shilling of loss with regard to any electrical installation of any kind when the work has been placed up in accordance with its rules, notwithstanding the enormous number of buildings containing electrical installations that have come before that office, comprising not only private houses, but all kinds of public buildings, mills, factories, workshops, warehouses, shops, etc.; and this immunity from loss has not merely been for a year or two, but extends back to the commencement of electric lighting in the beginning of 1882—over 13 years ago. A more satisfactory condition of things from a fire point of view it would be impossible to conceive.

It is with great surprise I learn that the Institute of Electrical Engineers is about to issue new rules for electrical installations inside buildings. I have to state that the Phœnix Fire Office will not for one moment recognise any such rules if they be issued, and it is well that all electrical contractors, not only in London, but throughout the country should be fully aware of this.

The Phœnix Fire Office will not depart from the course that long experience has proved to be so safe, and will require, as before, that in any building insured with it the electrical work shall comply with its rules. It has the responsibility of paying for fire losses, and therefore it is absurd to think that it would agree to anything that might practically place the disposal of its funds at the mercy of the views of an outside body.—Yours, etc.,

London, May 16, 1895. MUSGRAVE HEAPHY.

ACCIDENT.

SIR,—An accident occurred to one of our men in connection with the electric lighting of this town, and as we notice that an erroneous description of the causes which led to the accident have found their way into the papers, we beg to give you what we believe to be the true facts of the case so far as we have been able to ascertain them.

Our man went up a ladder placed against a pole in order to fix some new insulators for a new circuit. He hooked a linesman's vice on to the steel suspending wire of the street-lighting circuit, which was then switched off. This steel wire was probably charged by induction from the neighbouring private lighting circuit, so that when our man placed his hand upon it, and touched the lightning conductor or transformer case which was connected to the earth, he received what is called a static shock, harmless in itself, but which probably caused him to lose his balance. He fell 20ft. and has received serious injuries, which are, we believe, entirely due to his fall, and not in any way connected with the static shock, but we hope he will make satisfactory recovery.—Yours, etc.,

(For Chelmsford Electric Lighting Company)

May 14, 1895. A. H. POTT.

WHAT, WHEN, AND WHERE.

Institution of Electrical Engineers.

May 17, 8 p.m.—Students' Meeting in the Library of the Institution, 28, Victoria-street. "Aluminium," by Gerald C. Allingham.

Royal Institution, Albemarle-street, Piccadilly, W.

May 24.—"The Absolute Measurement of Electrical Resistance," by J. Viriamu Jones.

Physical Society, Burlington House.

May 24.—1. "On Mixtures of Ethane and Nitrous Oxide," by Dr. Kuenen. 2. "The Measurement of Cyclically Varying Temperature," by H. F. W. Burstall.

London Chamber of Commerce.

May 21.—Thirteenth Annual General Meeting.

May 23, 2.30 p.m.—Lecture on Telegraphy by Induction, by W. H. Preece.

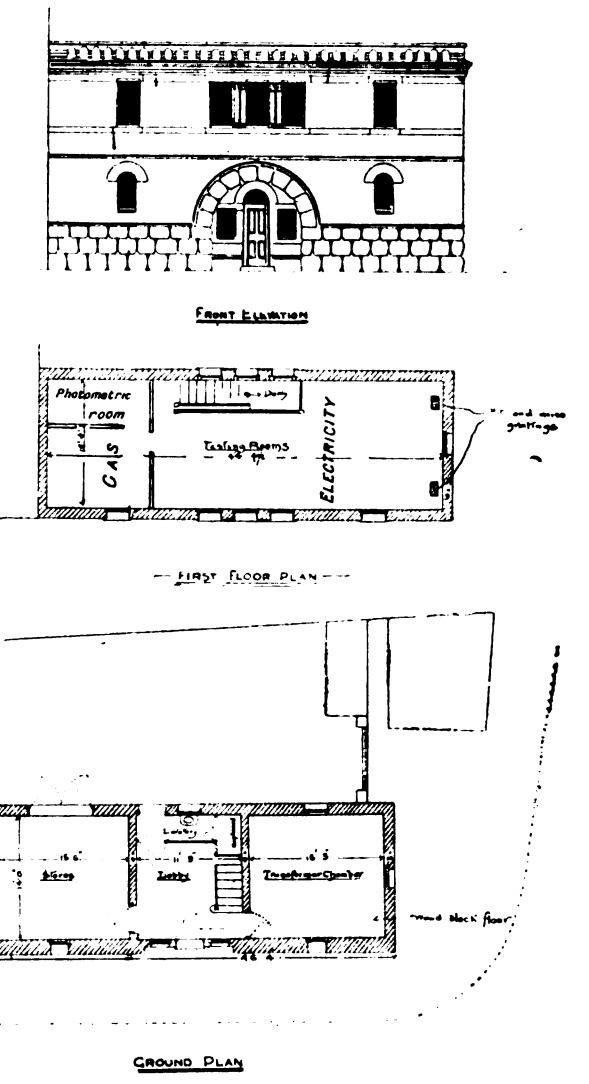
CHELTENHAM ELECTRICITY WORKS.

(Concluded from page 563.)

Cables.

All the cables used at Cheltenham are concentric. Both conductors are insulated, the dielectric consisting of bituminised fibre. A solid tube of lead is forced directly on to the outer dielectric under hydraulic pressure, and the cable is protected by a steel armouring where it is required for laying direct in the ground. It is only braided over the lead when required to be drawn into the conduits. The only difference in the cables used for high and low pressure current is in the variation in the insulation resistance provided, which is varied by the radial thickness of the dielectric.

The high-pressure trunk main connects the generating station with the distribution network ends at Manchester-street, where a sub-station has been constructed above ground.



FIGS. 18, 19, AND 20.—Views of Sub-Stations in Manchester-street.

The length of this main is 2,100 yards, and the section of the conductor used is 0·123 square inch. High-pressure mains run from the Manchester-street sub-station to smaller transformer stations throughout the town. The sections of these cables are either 0·062 or 0·020 square inch, according to the district they serve. As far as possible, all the high-pressure cables have been drawn into the lower ducts of the conduit, but in part of High-street it was found most convenient to use an armoured cable, which has been laid direct under the street.

All the low-tension distributing mains have conductors which are of 0·155 square inch section, and wherever possible the conduits have been utilised for their reception, armoured cables being employed only where the exigencies of the street work rendered this type of main more convenient. Special boxes were used in jointing the cables, which were also supplied by the Callender Company, who took great care in making the attachment to the mains.

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Consumers have been connected with the distribution network at pits constructed in the run of the conduit, in which cast-iron boxes are set, and from which double-wire service lines are led into the consumers' premises. Fig. 17 shows the operation of laying the cables down the promenade.

The whole of the street work has been executed by the staff of the Corporation, under the direction of the borough electrician and his assistants. Consequently, not so many people have been employed at a time as would have been the case had the work been let, and for this reason the operations have been carried out with less rapidity than might otherwise have been the case.

Sub-Stations.

The largest sub-station is in Manchester-street (Figs. 18, 19, and 20) and is used for various other purposes as well. It is a two-storeyed, red-brick building, 46ft. 4in. long, with an ornamental coping. On the ground floor are the transformer-chamber, a storeroom, a handsome lobby, lavatory, etc., with wood-block floors. On the first floor are a large electrical testing-room, a small gas-testing chamber, and a darkroom for testing the candle-power and efficiency of electric and gas lamps. In the transformer-chamber, besides the transformers, there are the necessary high-tension connecting and fuse boxes, the switch gear, and various low-tension connecting gear. In this building the Corporation will keep a check both on their own officials and on all the illuminants supplied in Cheltenham. It is proposed to add an additional floor to this station, in order to provide accommodation for an attendant.

Transformers.

The transformers used in the sub-stations at Cheltenham were manufactured by the Brush Company. Two sizes are used—12 and 6 kilowatts. Mr. Kilgour tested these transformers at Loughborough, and the following is an abstract of his report: The insulation resistance was tested (*a*) between primary winding and case; (*b*) between secondary winding and case; (*c*) between primary and secondary. In every case the insulation resistance was above that specified, and the mean value was about 250 megohms. The transformers stood a pressure of 3,000 volts between primary and case.

The 12-kilowatt transformers had an average iron loss of 96 watts, which is only 0·81 per cent.—the magnetising current being 0·072 ampere, which is 1·2 per cent. of the full current. The power factor is thus 68 per cent. In the six-kilowatt transformer the iron loss equals 69·5 watts, the magnetising current 0·049 ampere. The regulation of both of these transformers was good, the voltage drop between full load and no load for the 12-kilowatt being only two volts and the six-kilowatt 2·5 volts. We congratulate the Brush Company upon the efficiency of these instruments.

The running of the machinery will be attended to by the contractors for one month before it is handed to the Corporation, and during this time the responsibility for a regular supply rests with Messrs. Siemens and Co., the machinery remaining at present in charge of Mr. Stanley Franklin, their representative, who has had charge of the whole of the work done by that firm, and has carried it out most successfully.

PROJECTOR MIRRORS.

Much discussion has recently taken place, especially amongst naval and military experts, concerning the relative merits of the Mangin and of the parabolic reflector. The degree of success achieved by Messrs. Schuckert and Co. has caused many to form an idea that the parabolic mirror must necessarily be the best for purposes of projection. When considering glass mirrors silvered on the back it would seem that this idea is erroneous, and the good results obtained by the Nuremberg firm appear to be attributable rather to the employment of comparatively short focal lengths, and to the use of automatic horizontal arc lamps, than to the particular type of mirror made by this firm. Until recently it was thought to be impossible to construct a mirror on the Mangin principle, and having a focal length of less than two-thirds of its diameter. Messrs. Sautter, Harlé, et Cie., of Paris, have, however, now succeeded in so far reducing the focal lengths of their Mangin mirrors as to admit of the use of horizontal projector lamps. They claim that the new type of Mangin mirror is superior to the parabolic mirror produced by their German rivals, and have clearly cited their argument in a pamphlet recently issued.

This question is an important one from a manufacturing point of view, as it is well known that our Government have from time to time been obliged to place valuable orders for projector mirrors with the firms above mentioned. We therefore give the following translation of the pamphlet referred to, and shall be curious to learn if the cata-dioptric principle of mirror construction first suggested, we believe, by Sir John Herschel, is as successful in practice as it is stated to be by the celebrated French manufacturers of the Avenue de Saffren.

SOME NOTES ON THE RELATIVE MERITS OF MANGIN AND PARABOLIC MIRRORS.

1. *Parallelism of the Rays.*—Taking the best-known type of Mangin mirror—viz., that of 60cm. diameter—the focal distances

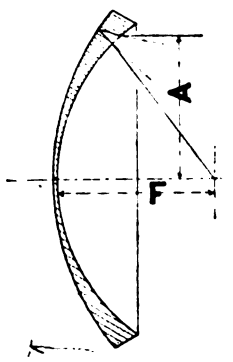

FIG. 1.

FIG. 2.

calculated and verified by experiment for various zones (*vide* Fig. 1) are as follows:

A.	F.
50mm.	318·2mm.
100mm.	318·3mm.
150mm.	318·3mm.
200mm.	317·8mm.
250mm.	317·8mm.
300mm.	318·0mm.

The differences between these are very small, and if the centre of the luminous crater be placed at a distance of 318·05mm. from the centre of the mirror, the focus of any portion of the reflecting surface will not fall on the axis further than ¼mm. from this point. This amount of aberration is less than that produced by the smallest accidental deformity of shape of the carbons. With a parabolic mirror, on the other hand, the aberration is greater, in consequence of the double refraction of the rays (*vide* Fig. 2) which in the case of the Mangin mirror is utilised to produce parallelism and to prevent aberration. Calculation shows that from this cause alone the aberration of a parabolic mirror amounts to 1½mm., or three times that of the Mangin mirror referred to above; and we may conclude that the aberration of a Mangin mirror is less than that of a parabolic mirror of the same diameter, and that in consequence the parallelism of the rays is more exactly obtained with the former than with the latter.

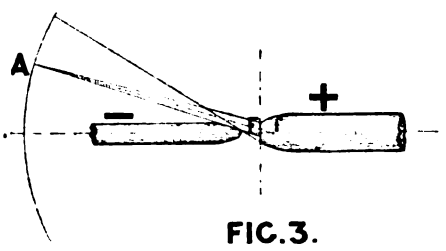

FIG. 3.

2. *Employment of Horizontal Lamps.*—With a horizontal lamp the source of light is in reality a luminous disc partly eclipsed by the negative carbon. The central zone of the mirror only receives rays from a portion of the crater, which portion viewed from a point in such zone presents the form of a crescent. In Fig. 3 it will be seen that the point A of the mirror, for purposes of parallel projection, must have its focus situated, not at F, but rather at a point, such as *f*, further off. This condition cannot be fulfilled with a parabolic mirror. The Mangin mirror can, on the other hand, be calculated so that its central portion may have a focal length longer than those of the marginal zones, and the conclusion is that the Mangin mirror utilises the rays emitted by a horizontal lamp more completely than does a parabolic mirror.

3. *Quantity of Light Utilised.*—On account of its great concavity, the Mangin mirror collects a great number of the rays emitted by the source. Thus, Fig. 4 shows that the angles of

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collection for a 60cm. by 31cm. Mangin mirror is 113deg., whereas that for a parabolic mirror of the same diameter and same focal length is only 101° 40′. The divergence of a beam depends solely upon the focal length, so that these two mirrors having the same focal length will produce, with similar diameters of crater, the same size of illuminated field. The Mangin mirror will, however, in such cases give a greater intensity of illumination of field owing to the greater quantity of light collected by it as compared with the parabolic mirror. In order that the parabolic mirror may collect the same quantity of light as the Mangin, it would be necessary to reduce its focal length to 27·9 c.m. (*vide* Fig. 5). But then the area of the illuminated field would be approximately increased in the proportion of the square of 279 to the square of 318—that is, by nearly 30 per cent.—and the intensity of illumination would be reduced proportionately. We may conclude, therefore, that given surfaces at given distances are illuminated more intensely by the use of the Mangin mirror than by the use of the parabolic mirror of similar dimensions.

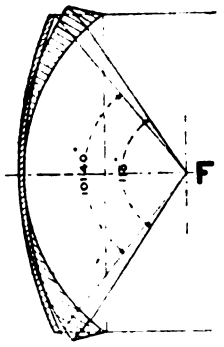

FIG. 4.

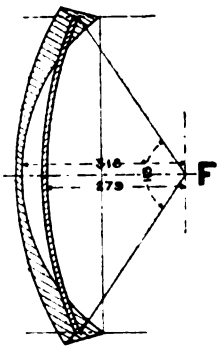

FIG. 5.

4. *Size of the Illuminated Field.*—Partisans of the parabolic mirror hold that their system is the only one which will give an extensive field, because such system lends itself to the employment of short focal lengths. This assertion is not exact, for the reduction of the focal length of the Mangin mirror is only limited by the necessity of preserving a distance between the focus and the glass sufficient to prevent the over-heating of the latter. Experience shows that for the above reason the focal length should not be shorter than one-half the diameter of the mirror. The 60c.m. Mangin mirror already nearly fulfils this condition as its focal length is 31·8c.m., and this result has been obtained, as has been shown, without any sacrifice of aplanatic qualities. There would be no difficulty in constructing a Mangin mirror of 90c.m. diameter with a focal length of 45c.m. More even could be done in this direction, but when the troubles due to over-heating are considered, it is found that nothing is gained by carrying the reduction of focal length beyond the limit above indicated. We may therefore conclude that the Mangin mirror allows of the production of an illuminated field which is quite as large as that produced by a parabolic mirror.

5. *Homogeneousness of Beam.*—Homogeneousness of beam, and consequent uniformity of illumination, are of the greatest importance for purposes of vision. An object is most easily distinguished when it is situated on the edge of the beam, the contrast between obscurity and the part brightly illuminated producing greater visibility. It is important, therefore, that the edges of the beam should be as luminous as the centre. To arrive at such a result it is necessary for all the zones of the mirror to give the same divergence. On referring to Fig. 4, it will be seen that the marginal zones of the parabolic mirror are further from the focus than are the central zones. The angles subtended by the source of luminosity at points on the margin of the mirror are thus smaller than those at points in the central portions, and the divergence of rays reflected from the marginal zones becomes less than that of rays reflected from the central zones. The rays, therefore, sent out from the marginal zones remain in the central portion of the beam, whilst the rays composing the edges of the beam are furnished entirely from the central zones of the mirror. In the Mangin mirror, however, in consequence of its greater concavity, the focal distances of the various zones do not vary to the same extent, so that it follows that the beam issuing from a Mangin mirror must be more homogeneous than that issuing from a parabolic mirror.

6. *Concentration of the Beam.*—One peculiar property of the Mangin mirror is that it allows of the concentration of the beam upon the illuminated object, and in consequence it affords the power of intensifying the illumination of such object. Again, by reducing the distance between the mirror and the luminous source, the beam can be dispersed without losing its homogeneousness. With a parabolic mirror, on the other hand, the source of luminosity must be rigorously kept in focus, otherwise the distribution of light in the field will be seriously affected, and the intensity of illumination in part reduced accordingly to a dangerous extent.

7. *Coloration of the Beam.*—It has been urged as an argument against the use of the Mangin mirror that the edge of its beam is coloured, and that the visibility of objects illuminated is therefore reduced. This statement is not borne out by experience. Whatever coloration exists at short range disappears totally when the object illuminated exceeds 300 or 400 metres in distance. This is easily explained when one considers that the rays emitted from various points of the mirror cross one another and get mixed up, so to speak, to such an extent that the light which has been decomposed in leaving the projector is subsequently recomposed, or combined, and it is an established fact that the chromatic aberration of the Mangin mirror is practically nil.

8. *Effect of Thickness.*—The loss of light due to the thickness of the edge of the Mangin mirror has often been urged in argument against its use by those who uphold the use of the parabolic mirror. Theoretically there is truth in the argument, but practically the loss of light caused by the thickness of the glass is absolutely negligible. Carefully conducted experiments have shown that the loss of light is only ·3 per cent. per centimetre of thickness. A 60cm. mirror has a thickness at its edge of 50mm., and consequently the loss of light passing twice through the extreme marginal zone only amounts to 3 per cent., and this percentage of loss is of course gradually decreasing towards the centre, where the glass is only 5mm. in thickness. It may be taken, then, that the loss of light by absorption due to the marginal thickness of the Mangin mirror is so small, that it may for purposes of comparison be neglected.

9. *Weight and Strength.*—The parabolic mirror is undoubtedly light as compared with the Mangin mirror. The advantage of lightness has, however, been much exaggerated. A Mangin mirror of 60cm. weighs 20 kilos, a parabolic mirror of the same diameter weighs 6 kilos. The difference of 14 kilos is the maximum that should exist between two projectors built respectively on the two systems. The parabolic mirror from its very lightness, and consequent flexibility, requires a massive mounting, and, if necessary, the extra weight of the Mangin mirror, which in itself possesses considerable rigidity, could be compensated for by a reduction in the weight of its mounting. If Mangin projectors are generally heavier than parabolic projectors, it is therefore really because the makers of the former type consider that this class of apparatus, generally speaking, requires to be of especially massive construction, in order that it may not suffer when placed in unskilled hands; and it may be stated generally, that the extra weight of Mangin mirrors, when compared with parabolic mirrors, is compensated for by superior strength.

10. *Uniformity of Manufacture.*—In the construction of Mangin mirrors, the principle on which they are ground allows of the possibility of designed dimensions being rigorously adhered to. This is not possible with parabolic mirrors. The grinding of the Mangin mirror is performed by working the glass on spherical metallic formers, to which are communicated movements of rotation and of translation. Whatever be the initial positions of these tools, the resultant curvature comes out correctly, and is independent of exactness of form of the tools, of the motion imparted, of the skill of the workmen, of accident to the machines, and of the wear of the working parts. The spherical working eliminates the inequalities of the tool, and also those of the glass, and the more prolonged the operation the more perfect is the curvature obtained. This property of the system is valuable. It supplies practical means of constructing reflectors of uniform curvature and having identical properties. Thus, in a lot of 20 Mangin mirrors, no single mirror would be found the optical constants of which would differ from their calculated values by more than from ·1 to ·2 per cent. Parabolic mirrors are, on the contrary, extremely difficult to construct accurately. In practice an approximation has to suffice. The mechanism employed to cut the glass to a parabolic curve is complicated and delicate, and must be set with great exactness. Skill on the part of the workman and continuous supervision of his work are necessary in order to prevent an undue departure from the theoretical section. The unavoidable play between different pieces of the machine, and the wearing of the rubbing portions of the mechanism, seriously interfere with the uniformity of a batch of reflectors turned out from the same machine.

As it is difficult to determine the definite defects of a finished glass reflector, and as it is impossible to test it during the process of cutting, the maker is often not in a position to remedy defects of form due to workmanship. Not knowing the defect, he is unable to arrive at the cause. When the machines are new their performance is fairly satisfactory, but as manufacture proceeds the results show greater and greater defects. The effect of imperfect curvature is to prevent the various zones of the mirror from having same focal lengths, and it is not uncommon to find a difference between the focal lengths of the marginal and central zones amounting to as much as 15mm. to 20mm. In such a case the luminous rays are unevenly dispersed in space over an angle considerably greater than that representing the theoretical divergence of the mirror. The illumination of the objective being inversely proportional to

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the square of the angle of divergence, the useful effect of such a projecter will be reduced very seriously. Taking a particular instance, let us suppose a 60cm. parabolic mirror, which should have an angle of divergence of but 2° 20′ to have (as is frequently the case) an angle of divergence of 3° 0′. The illumination of the field will then only have a mean intensity of 49/81, or five-eighths of what it should be had the mirror been accurately constructed.

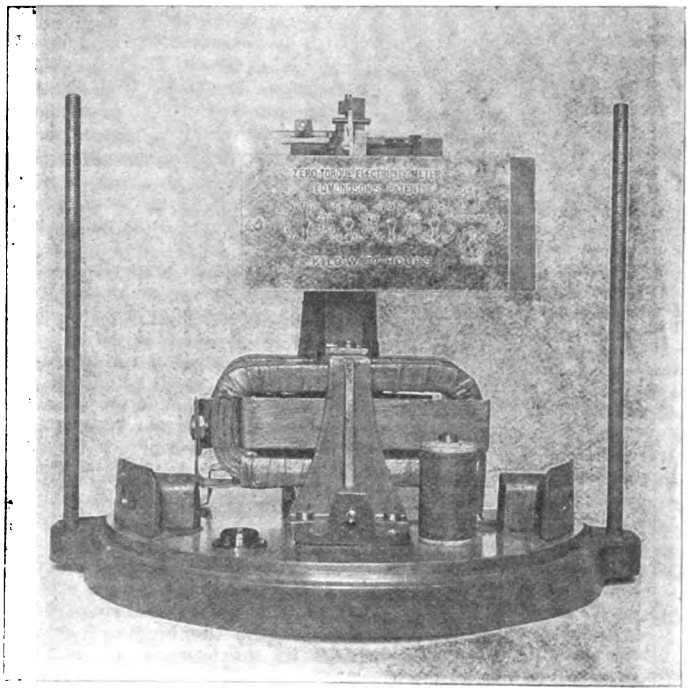
In proof of the above, recent experiments made by the Russian artillery staff may be quoted.* In these experiments the images of rectilinear grids or network reflected by Mangin and Schuckert mirrors were photographed, and this method of investigation showed in a most striking manner, not only the defects of the parabolic mirrors, but also their want of uniformity of manufacture.

It may be fairly concluded that Mangin mirrors can without difficulty be made of uniform quality, but that parabolic mirrors, on the other hand, vary much in their quality, which depends upon the condition of the machines and upon the skill of the workmen. Had the invention of the Mangin mirror been made subsequently to the introduction of the parabolic mirror, it is thought that such invention would have been hailed as an important step in the progress of the development of projectors.

THE ZERO-TORQUE ELECTRICITY METER.†

BY JOSEPH EDMONDSON.

The zero-torque electricity meter, as its name implies, consists of a zero-reading dynamometer, combined with mechanism



Zero-Torque Meter—View of Internal Mechanism.

for measuring and integrating, at short intervals, the torque exerted on the moving coil by the current going into consumption.

The Siemens dynamometer is familiar to electricians as an instrument of the utmost simplicity and accuracy, giving, when coupled as a wattmeter, absolutely proportional readings throughout any range. Its obvious advantages in these respects point to it—in a form somewhat modified, but retaining all its essential features—as a pre-eminently suitable basis for a supply meter, and numerous attempts have been made to adapt it to this purpose. Heretofore, however, the action of all such instruments has depended on complicated arrangements for making and breaking contact. In the zero-torque meter these are entirely avoided. The moving coil of the dynamometer is in a closed circuit which is never broken. It carries a small steel stop which controls the registering without in the slightest degree interfering with the free and frictionless action of the instrument.

The motion of the moving coil being limited to an arc of less than 1deg., permits the use of a durable steel wire suspension instead of the delicate suspension of the ordinary dynamometer. A torque of about 90deg. is given to the usual spiral spring every two minutes by a reciprocating quadrant, or "mangle wheel," driven by a vibrating motor consisting of a magnet and its armature. This motor is controlled by a small gravity-driven pendulum, starting automatically and having a sparkless contact (Oulton and Edmondson's patent).

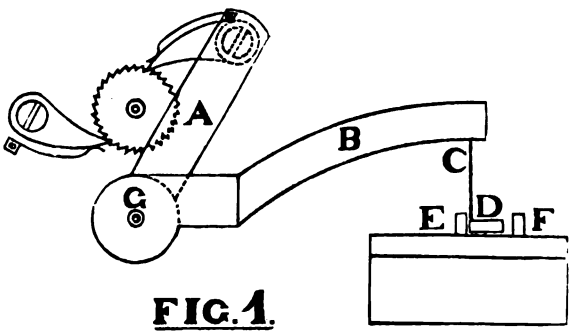
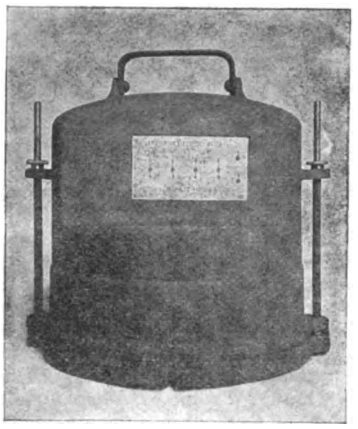


FIG. 1.

The action of the instrument is illustrated by Figs. 1 and 2, in which A is an arm pivoted at G, carrying a click working into a ratchet wheel, and driving the registering train. It receives a reciprocating motion from the vibrating motor. Fixed on its arbor is the arm B carrying the steel pin C. The flat steel stop D, on an arm projecting from the moving coil of the dynamometer, is free to move between the stops E and F. When the current is nil the stop D remains against the stop E, as in Fig. 1. In this position the pin C comes down upon it at each vibration, and the arm A is thus prevented from vibrating far enough to take a tooth of the ratchet wheel. The registering is therefore nil. But when the force of the current moves the stop D to the right, and it assumes the position shown in Fig. 2, the pin C can descend into the space between the stops D and E, the arm A can vibrate to its full extent, and the registering proceeds. This continues until the reciprocating quadrant or



Zero-Torque Meter—External Appearance.

"mangle wheel" in its motion to the left, acting through the spiral spring, exerts on the moving coil of the dynamometer a torque equal to that exerted by the current, brings the stop D back to the position shown in Fig. 1, and stops the registering. This action is repeated with each reciprocation of the "mangle wheel."

As the period during which the registering proceeds is exactly proportional to the torque exerted by the current on the moving coil of the dynamometer, the diagram of registration is a straight line. A 25-ampere meter will register from 1-10th ampere upwards. The total current required for the

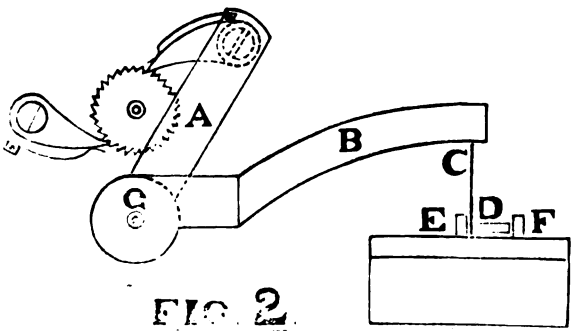


FIG. 2.

shunt circuit and the vibrating motor never exceeds, and is generally less than, 2-100ths of an ampere. The moving coil of the dynamometer, being in the centre of a cylindrical iron case, is shielded from external magnetic influence. The meter is calibrated to read direct in kilowatt-hours with a constant of 1.

* *Vide* translation of M. Tchikoleff's article in *Electrical Engineer* of April 19, 1895.

† Paper read before the Institution of Electrical Engineers, May 9.

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ON THE RECENT DEVLOPMENT OF THE SINGLE-ACTING HIGH-SPEED ENGINE FOR CENTRAL-STATION WORK.*

BY MARK ROBINSON, MEMBER.

(Continued from page 533.)

ERRATA.

Page 530, col. 2, line 15 from bottom: after "in a double-acting engine" add "except the special packing rings, and those only by completely duplicating them upon each piston."

Page 532, col. 2, line 17 from top: after "to the other" add "except by absolutely duplicating the packing arrangements of each piston."

It is obvious that with modern pressures it would be better to compound the engine—to give it one smaller cylinder and one larger, and add to the diagram the piece shown in dotted lines in Fig. 7, while making the division of temperatures more equal, as is also shown in Fig. 7. But whether the engine be simple, compound, or triple expansion, if it is single-acting there will always be one cylinder—viz., the last of the series—to which the Cornish cycle may be applied. Mr. Willans applied it in his engine when circumstances were favourable, and he called it the "transfer plan." The steam, when it exhausts through the central valve from the upper to the lower part of the low-pressure cylinder, does not pass away at once to the condenser: it remains in the cylinder (offering no material opposition to the movement of the piston, because the two sides of the piston are in free communication), and passes to the condenser during the succeeding down stroke. It adds to the engine another stage of temperature division, though not of large range, and so lessens the range in each of the others.

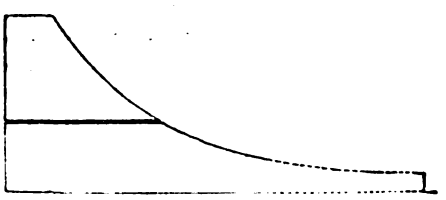

FIG. 7.

Simple as it sounds, the "transfer" adds several parts to the engine. The cylinders are lifted a good deal, as a "transfer-chamber" is required below the low-pressure cylinder; the trunks or hollow piston-rods are lengthened; and an extra valve and an extra gland are required in each line, and, of course, involve extra friction. Thus it is only under particular conditions of pressure, etc., that it is worth while to use the "transfer"; it is often better to add another complete stage of expansion rather than the transfer. It is, nevertheless, useful in cases where, for some extraneous reason, such as very great fluctuation of load, it is convenient to cut down the number of stages of expansion, as in an engine for electrical railway work. In such an engine the average load is usually but a small proportion of the extreme load, and the total cylinder volume should be so chosen as to give the best ratio of expansion, and therefore the most economical consumption, at the average load. It might then be impossible, without much complication, to obtain the extreme load at all, if the first cylinder were relatively so small as that of a triple-expansion engine must be, and if the cut-off in it, for normal load, were as late as in a triple-expansion engine it ought to be; it is better, therefore, to use a compound engine, gaining the needful expansion by cutting off early for average loads, and of course cutting off late (economically, too late) for extreme loads. Economy suffers from this, but it can be partly restored by adding another temperature-division stage in the shape of the "transfer." Where the steam pressure exceeds 160lb. it is also worth while to add the "transfer" to a triple-expansion engine; it takes it half-way towards quadruple expansion, the latter not being, in a Willans engine, worth the complication it introduces, until the pressure is well over 200lb.

It will be noticed that the last statement is qualified by the words "in a Willans engine," and by this is meant that the Willans engine, even if the "transfer" is not used, has always one definite source of superiority over other engines working with the same number of expansion stages—*i.e.*, compound or triple—namely, in respect of the smallness of its temperature range in each cylinder. The explanation is that, in all the expansion stages except the last one—*i.e.*, in the high-pressure and intermediate stages—the Willans engine works necessarily upon the Cornish cycle; the "transfer" is applied in those stages as a matter of course. In double-acting engines, the exhaust steam passes direct from one cylinder to the next, placing the two in communication through the receiver, and therefore exposing the first of the two to the same temperature as the second; in the Willans engine each cylinder exhausts successively in the Cornish manner, and the power developed in each is represented, as in the Cornish engine, by two diagrams—that from the cylinder proper and that from the "receiver." The effect is that the temperatures of the high-pressure and intermediate cylinder, for instance, do not overlap, as in other engines they do, and the range in each is consequently smaller. It is perhaps the most distinctive feature in the Willans engine; it is highly advantageous to it; and it is of interest as a meeting-point between the very oldest and the very newest, and as bringing together in significant association the names of James Watt and Peter Willans—an association which to the author has always appeared natural, and which he believes will at no distant time be so recognised by all.

Brake Efficiency.—Having fully dealt with the three special points of advantage peculiar to single-acting engines, enumerated in paragraph 11, it will be of interest to investigate the effect of the single-acting principle upon brake efficiency. Generally, a single-acting engine has higher brake efficiency when fully loaded than a double-acting engine. The perfect lubrication of all brasses and bearings in the splash-chamber of a single-acting engine naturally reduces that part of the friction to a very small figure, and the total absence of back-lash or "lost motion" is believed to tell as strongly in the same direction. On the other hand, single-acting engines, or at least the Willans engines, though they have no stuffing-boxes, have unusually numerous piston and other rings, mainly owing to the practice of putting a complete tandem engine over each crank—or three cylinders over each crank, if triple expansion. Nine complete cylinders,* as fitted in three-crank triple-expansion engines, with their valves and glands, imply a large number of rings, and even in a two-crank compound engine there are a good many. The special design of the rings, which has been fully described in paragraph 12, coupled with accuracy in manufacture, bring the total friction, however, to a reasonably small amount. After some months' running it is not uncommon to find the brake efficiency of compound engines as high as 92 per cent., but on trial at the works, when the rings are new and not yet brought up to a good face, it is rare to get more than 90 per cent., and 89 per cent. would not be thought unsatisfactory. In a triple-expansion engine 87 or 88 per cent. is a good result when new. Though experiments are sadly wanting, it is believed that these figures are much about the same as those for good double-acting engines, in which there is less ring friction but more bearing friction.

Mr. Willans's diagram of total water consumption, shown in the discussion upon Mr. Crompton's paper upon "The Cost of Electrical Energy,"† has familiarised everyone with the rather puzzling fact, that in almost all trials at Thames Ditton, with good dynamos, the lines representing total water per electrical horse-power and per indicated horse-power remain nearly parallel for all loads; in other words, the combined engine and dynamo losses, and *a fortiori* the engine losses alone, are as great at light as at heavy loads. Makers of some double-acting engines are believed to have obtained results differing from this, and showing a considerably reduced engine friction at light loads. Probably both are right. In both types the ring-friction is constant. In the single-acting engine the bearing friction is also practically constant, because its maximum is so small that variation in it is unimportant. In the double-acting engine the bearing friction‡ at full load is relatively great, and as it falls off at light load, it considerably reduces the total friction. If the single-acting engine beats the other handsomely at full load (as it often does), the effect may only be to bring them together at light load; but where the double-acting engine is exceptionally free from friction, and makes a more even fight with the single-acting engine at full load, it may have a distinctly higher efficiency at light load.

The value of improved efficiency at light loads is not large, for the unwisdom of running an engine at light load for any permanent use is too great to be redeemed by any probable saving in engine friction. If light loads have to be faced, there should be a smaller engine to undertake them, small enough to make a full load of them, or nearly so.

* Paper read before the Institution of Electrical Engineers, May 9.

* Twelve complete cylinders, has been unkindly said, reckoning the guide or cushion cylinders. But the reproach is not quite just, since the guide cylinders, with their ring-less pistons, merely represent the guides and cross-heads of other engines, and are quite as simple.

† *Proceedings* of the Institution of Civil Engineers, vol. cvi., 1890-1.

‡ In "bearing friction" is here included that which is assumed to be due to back-lash—*i.e.*, to the incipient "knock" necessarily present where there is alternation of stress. It is to be remarked that the heat generated by knock upon brasses is wholly lost; but heat generated by piston-ring friction is partly utilised in heating the cylinder walls and pistons, and so reducing condensation. In the single-acting engine, therefore, a greater proportion of the friction loss is returned in reduced consumption of steam, than in a double-acting engine having the same total friction.

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The possible higher efficiency of double-acting engines at light loads is well illustrated in a paper read by Mr. Alexander Siemens before the North of England Institute of Mining and Mechanical Engineers in December last. It describes fully a series of trials in the central power station belonging to his works at Woolwich between a Willans engine (three-crank) of 300 i.h.p. and a Belliss double-acting engine (two-crank) of the same power, and running at the same speed, 350 revolutions per minute. The dynamos were apparently identical, and all the conditions appear to have been as favourable to a fair test as they can ever be in a commercial engine-room. There are anomalies in the very interesting figures given, but there is no reason to mistrust their general tendency. At 270 i.h.p., the highest power used, the combined efficiency of the Siemens-Willans plant was 86 per cent. against 85·1 per cent. in the Siemens-Belliss, but at light loads the advantage of the latter was considerable, as appear below :

	Electrical horse-power.	Indicated horse-power.	Horse-power lost in engine and dynamo combined.
Willans set	231·2	268·9	37 7
Belliss set	230·4	271 6	41 2
Willans set	114·6	149 2	34 6
Belliss set	120·3	144 7	24 4
Willans set	60·9	95·7	34 8
Belliss set	60 5	79·4	18 9

There is much in these figures which is with difficulty reconciled with any probable assumption as to the respective engine and dynamo losses ; but there is no doubt that in the double-acting (Belliss) engine the friction became very small at light loads. As it had but two cylinders and ran at high speed, there could be but little ring friction at any load, and it looks as though at light loads the bearing friction almost disappeared ; probably the crank-pins and shaft "floated" in their brasses, permanently separated from them by the oil which was forced in under pressure. It is, however, instructive to notice that with increasing load, and notwithstanding its great advantage in regard to ring friction (it probably had little more than one-third as much ring friction as the other engine), the total friction of the double-acting engine rapidly overtook that of its rival, and it is evident that had trial been made at the much higher mean pressures frequently used in non-condensing stations, the advantage of the single-acting engine would have been very marked indeed. It seems possible that, although the exceedingly elegant system of lubrication adopted in this double-acting engine is effective when the pressure per square inch on the brasses is light, yet the alternating pressures of the parts begin to produce their natural effect at heavier loads. In the single-acting engine security from wear and knock is obtained by ensuring that the revolving journal shall remain always in steady contact with the same brass : in the remarkable double-acting engine described, an even more perfect result is perhaps obtained at light loads (which, however, are not of the highest importance) by providing that the revolving journal shall touch neither brass ; but it remains to be seen whether in continuous running at heavy loads, the brasses will not relapse more or less into the condition of those of an ordinary double-acting engine. It is at least plain from the Woolwich figures that even at 270 i.h.p. the bearing friction (as distinguished from ring friction) of the double-acting engine is enormously greater than that of the single-acting engine, and the law of its increase might well repay investigation. Provisionally, it is difficult to resist the conclusion that bearing friction—*i.e.*, the actual rubbing of the journal upon the brass—is of small importance in engines in which the lubrication is very perfect, as in the Willans engine through its oil-bath, or in the Belliss engine through the forcing in of oil under pressure*; and that, in double-acting engine at heavy loads, the most important element of friction loss—or it may be safer to say of power loss—is to be traced to the knock of the journal as it changes over from one brass to the other—a source of loss which the single-acting (constant-thrust) engine avoids altogether. Whatever be the ultimate verdict, no one can withhold admiration for the ingenuity and indeed beauty of the device by which it is sought to overcome so great a difficulty, and it is most satisfactory that in such an interesting and important trial the double-acting principle has been, and continues to be, represented by so perfect an example.

Passing to the results of experience with single-acting engines in the last few years, it may be well to deal separately with (*a*) steam consumption, (*b*) durability, (*c*) lubrication, (*d*) vibration.

Steam Consumption (*a*).—The consumption of the best-known type of single-acting engine, under all loads, is known not only from the almost historic series of tests conducted by Mr. Willans, but from numerous other trials carried out at Thames Ditton. It is, however, a frequent objection that the small consumption of steam per kilowatt upon test bears little relation to the actual consumption of coal per kilowatt sold ; and doubt is often expressed whether the engine consumption does not increase with use and wear, or whether test figures are not vitiated later by variation in load. It is satisfactory to be able to answer this question. At the stations of the Westminster Company, Dr. Kennedy, F.R.S., has for a long time had accurate records kept of the quantity of water supplied (by meter), as well as of the load upon each engine separately. The "Thames Ditton" consumption for every engine at all loads is, of course, known, and has been compared with the actual consumption, and after allowance for steam known to be condensed in pipes and used in pumps, etc. (mostly ascertained by experiment), the result is an almost exact balance. Probably there really are unrecorded losses for which a margin would have to be provided, if it were not that the engines work at a little less than the calculated consumption, since the latter is, of course, based upon the trials of the same engines at the makers' works when new and stiff. Some of the engines at the stations had been at work for over five years, and few for less than two years, so all had had time to bring the rings and other wearing surfaces into the best condition for economy.

At the meeting of the Institution of Mechanical Engineers on April 24, 1895, the above facts were well shown in a diagram exhibited by Mr. G. M. Clark. Two cases were taken from the same station : one for a heavy winter load, covering 24 hours ; the other for a week's load in summer. The leading particulars were :

	Winter load (24 hours). 3,350		Summer load (one week). 9,000	
Output in kilowatt-hours				
Measured total water consumption per kilowatt-hour ... lbs	—	46	—	48
Measured steam consumption of engines at Ditton trials (full load, non-condensing), per kilowatt-hour ... lbs.	32·5		32·5	
Calculated addition to steam consumption (non-condensing) on account of low load-factor ... lbs	8 0		9 5	
Total calculated engine consumption per kilowatt hour ... lbs	40·5		42·0	
Measured consumption of steam in pumps per kilowatt-hour ... lbs.	1 5		1·5	
	42 0		43 5	
Balance attributable to condensation in pipes, leaks, etc., ascertained by previous trials to vary from 7 per cent. to 11 per cent. of total consumption ... lbs.	4 0		4·5	
		46		48

These figures may be commended to those gentlemen of the technical Press who tell us that theory never helps anyone ; that no engine builder knows within pounds what weight of steam his engine is likely to use in practice ; and who apparently reckon no man practical if he knows the reason for what he does or is able to foresee the result.

It is important to enquire whether the economy of the single-acting engine may be expected to make any notable advance beyond the results hitherto obtained. The answer is yes, but here (speaking of the Willans engine only) it is necessary to distinguish between actual engines as fitted in the majority of stations and the new type only recently made. Owing to various circumstances, the demand for the central-valve engine came at first chiefly from users who desired to work without condensation, and its fame was first established by Mr. Willans's paper upon non-condensing trials, in which he showed figures not before supposed to be possible for non-condensing engines (such as a consumption of 18·45lb. of steam per indicated horse-power with 170lb. pressure, triple-expansion ; and 19·45lb. with 150lb. compound). But Mr. Willans's paper, and his practice at that time, did more than this—they pricked the bubble of over-expansion. Here was a little non-condensing engine which, with five or six expansions, used scarcely more steam per indicated horse-power, and obviously less per brake horse-power, than many large (not to say overgrown) condensing engines which expanded their steam twenty-fold or even thirty-fold. But the ease of the triumph tended to mislead, and the same ratio of expansion, without the moderate increase which was really desirable, was provisionally attempted in condensing work. A few months before his lamented death, Mr. Willans carried out a complete series of condensing trials, which proved that, while nothing could justify the excessive expansion formerly allowed by some makers, the Willans engine, as then made, erred, though less seriously, in the other direction. A new series of engines has since been designed in which the

* If the mere rubbing of the journal and brass together at heavy loads were seriously important in a thoroughly lubricated engine, the Willans engine would show increasing friction at heavy loads. It does not do so, and even the moderate increase (in engine and dynamo together) shown in the figures extracted from Mr. Siemens's paper is exceptional. The increase in the Belliss engine, therefore, can hardly be due to this cause, and other reasons must be found for the increase which undoubtedly occurred.

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necessary greater expansion is provided for, the ratio of the cylinders being altered at the same time; and in which a number of minor improvements, tending to the suppression of petty losses, considerable in the aggregate (but much less important in a non-condensing than in a condensing engine), have been introduced. From these engines, which have but just commenced to find their way into station work, great economy may be expected. The earliest was a triple-expansion mill engine indicating up to about 500 h.p., driving the flax mill of Messrs. Gunning and Campbell, Limited, at Belfast, at 300 revolutions per minute, and in some very complete trials carried out last year by their consulting engineer, Mr. A. Basil Wilson, M.I.M.E., after the engine had been at work for about six months, a consumption of 12·48lb. of steam per indicated horse-power was recorded. This places the single-acting engine, to say the least, in the very foremost rank of economical motors. Evidently electrical engineers need not fear that they must abandon economy if they do not "stick to the builders of mill engines and marine engines." In fact, it seems not impossible that, while advocates of the "mill engine" are pleading for central-station work, they may find themselves the victims of a flank movement, and learn too late that their special patrons, the mill engineers and owners, are becoming as open-minded as the electricians, even to using "electric light engines" for driving their mills.

It may be remembered that in Mr. Willans's paper on non-condensing trials figures were given for one condensing trial at 170lb. pressure, carried out with the same triple-expansion engine as had been used for the non-condensing trials; the consumption was 15·1lb. per indicated horse-power per hour. With the old engine that result has not been much improved upon, so it may be reckoned that the new series are about 15 per cent. better in steam economy than the old, when condensing. For non-condensing work, and for condensing work in special cases, the old series engines are still the most suitable, while from the smaller cylinder capacity they are less costly to make. The engine at Messrs. Siemens's works at Woolwich, the trial of which against a Belliss engine has been before referred to, was of the old pattern, compound, but fitted with the "transfer" arrangement; in other respects it was of the proportions now recognised as suitable for non-condensing only. The steam consumption at full load is given by Mr. Siemens, in his paper before quoted, as 19·5lb. per indicated horse-power, against 22·4lb. in the double-acting engine. It is understood that these figures of steam consumption are based upon the total water actually supplied to the boilers, with a deduction only for steam used in pumps; they presumably include pipe condensation and leakages of all kinds, and it is probably from such causes, rarely absent from a commercial engine-room, that the water used comes out some 2lb. per indicated horse-power per hour above that due to the proper steam consumption of the old type Willans engine at the load and pressure stated. (The vacuum is not given.) Of course the Belliss engine was similarly affected.

Reference has been made to the numerous cylinders of the Willans engine, due to the practice of erecting a complete engine over each crank. By adding to the number of pistons and valves the ring friction is, of course, increased, and it is equally certain that condensation is increased, and economy affected unfavourably, owing to the larger aggregate surfaces of the two or three small cylinders which take the place of what might otherwise be a single large one. On the whole, however, the advantages appear to outweigh the drawbacks. The first and most obvious is even turning moment. Whatever the change in load, in pressure, or in cut-off, it is at least certain that the cranks will be driven equally, and this is an advantage not to be lightly surrendered for only a small gain in economy. But the same tandem arrangement of cylinders is also the condition of the complete application of the Cornish cycle to all the cylinders except the low-pressure one: the perfect separation between the temperature ranges of the successive cylinders is impaired if their strokes do not succeed each other at intervals of exactly a revolution, as they now do in the tandem pattern; even economically, therefore, there is something to be said in favour of the many small cylinders. Turning to other considerations, it may be thought at first that the large number of small cylinders and multiplication of parts must lead to increased weight and cost, as well as to difficulty in dismantling and overhauling. As to weight, it is almost certain that it is not increased. Cylinders weigh roughly in proportion to volume, but the weight of a piston tends to increase faster than the area; three pistons, each of one square foot area, will weigh less than one of three square feet area. To cylinder covers the same consideration applies. Piston-rods, connecting-rods, and crank-shaft should be unaltered. There may be some saving in machine work, but small pieces are, after all, easier to machine than large ones, and pieces which are made in batches of, say, 36, are more economically manufactured than larger pieces made in batches of 12 only. Then the identity of the several lines of parts and their interchangeableness are often helps to the user (especially in case of repairs), while the lightness of the individual pieces and the regular and simple routine in removing them make dismantling easy. A Willans cotton-mill engine of 650 i.h.p. pulled up one day after the dinner hour, with brasses cut to pieces and crankshaft badly scored. (Of the cause, it need only be said that emery powder was found in the bearings and in the crank-chamber.) Next morning, after breakfast, it started again with new brasses and crankshaft in good order. By good luck another engine of the same size was being erected in the same town, and its brasses were at once appropriated for the disabled engine, and every necessary repair thoroughly carried out during the night. It is true that in this case the cylinders did not require to be lifted, but there have been as rapid repairs to cylinders, pistons, etc., where internal damage has been done by water. Some years ago three three-crank triple-expansion engines of 300 i.h.p., to save the reproach that they had nine cylinders each, were designed with only six cylinders—viz., one high-pressure, two intermediate, and three low-pressure. It is remarkable that not only have all later engines of the same type been fitted with the orthodox nine cylinders, but the original engines in question are now being altered to the standard pattern. With larger sizes may, possibly, come different views, but as regards the present standard patterns for 700 i.h.p. or 800 i.h.p., experience gives little support to objections against the number of cylinders.

(To be continued.)

ALTERNATING AND INTERRUPTED ELECTRIC CURRENTS.*

BY PROF. GEORGE FORBES, M.A., F.R.S., M.I.C.E.

LECTURE II.

(Continued from page 542.)

Now, these different phenomena of induction, pleasing as they are, and useful as they are to the electrical engineer, are matters that require considerable caution in their handling. There are some troubles which would arise if sufficient attention were not paid to them, and I am going to deal—it may seem at an unnecessary length—with some of the analogies to show you what happens when we suddenly break a circuit containing much self-induction. Before doing that, I wish to show you a model, which I am enabled to do by the kindness of Prof. J. J. Thomson, which was introduced by Clerk Maxwell to illustrate this phenomenon that I have been describing to you — the phenomenon of induced currents in a secondary wire or coil. It is an instructive experiment to look at, and it is an interesting one, because it shows how thoroughly Clerk Maxwell's ideas were connected with mechanical phenomena when he was working out his electrical theories.

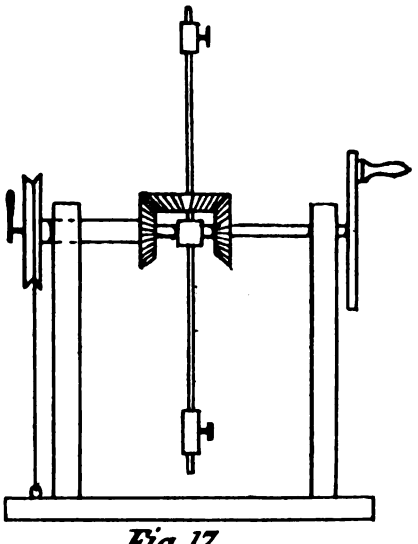

Fig. 17

Here you will notice that I have two wheels (Fig. 17)—one which I am turning, and a second one which is not turning at all. The one which I am turning at this moment represents the primary circuit, and the one which you see is not turning represents the secondary circuit. These wheels are connected, not by a rigid axis, but by means of three bevelled wheels in the centre—one keyed on each of the two horizontal shafts, and the third running loosely on a shaft, at right angles to the others, forming one of four cross-arms, having heavy weights at their extremities, and therefore possessing considerable momentum, and so resisting any tendency to set them in motion round the horizontal shaft of the hand-wheel, to a sleeve running on which they are attached. The consequence is that if I suddenly try to turn this handle round, the

* Lecture delivered before the Royal Institution.

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momentum of the intermediate gearing will prevent it from turning round at first, and the secondary wheel will turn in the opposite direction to that in which I am turning the first—*i.e.*, if I do it suddenly enough.

But now the intermediate gearing is rotating, and if I suddenly stop the hand-wheel, then the secondary circuit goes on rotating in the same direction in which my hand has been going. This is a very beautiful analogy, but, of course, you must not look upon it as more than a rough sort of analogy. It is not an explanation. If it were an explanation we should have to say, I suppose, that this beautiful gearing and these masses at the end of the cross-arms are parts of the ether. In the true case a motion is given to the ether in the one direction, and the moment the ether has motion it transmits it to the other wire. That it could be an explanation is, of course, quite out of the question. But a mathematician finds a very great help from getting a mechanical thing to illustrate what he wants to arrive at in his theories. I remember that in the celebrated Baltimore lectures which Lord Kelvin gave in 1884, he was trying to work out a theory of an ether and vibrating molecule giving light, and he worked out then and subsequently a view of the ether in which every part of the ether consisted of an assembly of gyrostats. I remember perfectly well his saying: "I do not believe ether is made up of gyrostats, but I am never contented with any theory until I can get a mechanical analogy to satisfy me. After we have the mechanical analogy which satisfies the conditions, we can then work on to get something in the ether which will be analogous to it in the method, though different to it in the mechanical conception."

Now, I want to show you some of the analogies which help to show us the enormous dangers which may be incurred in practice by suddenly breaking our circuits which have very large self-induction. In an alternating-current system, like that which has just been put in at Niagara Falls, the self-induction of the transformers is something very large indeed. And if we were to permit insulated cables to be laid in the earth over considerable distances, the capacity would also be very considerable of these cables. The combined effects of the capacity and of the self-induction would lead to a great deal of trouble, and it has been my effort to reduce the capacity of the cables, and to lay them in such a way that there should be as little capacity as possible, so that that source of trouble should be as much obliterated as could be. Also I introduced the plan of lowering the frequency of the alternations as low as possible, which also assists largely to get over troubles due to capacity. I need not go into that question of the reduction of the frequency at the present moment; but I may say that the further we have gone in the matter the more thankful we are that we realised the necessity in time, and have lowered the frequency to a figure that has never been reached before. It is not only an enormous safeguard to us in countless other ways, but it enables us to use apparatus of a simplicity which would have been impossible with the higher frequencies.

Now, neglecting the question of the capacity, let us deal simply with the question of the self-induction. It is remarkable what great difficulty I have had in getting people to realise the danger that there is in suddenly breaking these circuits containing enormously powerful self-inductions; but I have insisted throughout that it is indispensable to the success of that great work at Niagara that no circuit carrying large currents which are used with these self-inductions shall ever be suddenly broken. I found manufacturers relying simply upon their past experience, and not looking into the new conditions caused by the enormous size of the machinery. I found able manufacturers unable to realise this point. They had noticed, when they broke the circuit of an alternating current with some self-induction, large sparks at the switch. Several had the notion that if they could get rid of these, that was all they had to do. Their desire was to make the break at the switch as sudden as they possibly could, so as to prevent sparks and a train of fire from appearing there. As a matter of fact, by doing so they were endangering the whole system by introducing an enormous E.M.F. of self-induction tending to break down the whole system in one part or the other. I will show you one or two mechanical analogies to illustrate this; and, first, I will adopt the analogy of flowing water which I spoke of last time, which is an extremely useful analogy.

I have here (Fig. 18) a pipe through which I am able to allow water to flow downwards. There is in the middle of the suspended part an opening, which is at present closed. A little brass tube projects from the main tube, and that brass tube is closed simply by means of a membrane of paper, which prevents the water from escaping there. That piece of paper in this analogy represents the insulation on the cable, and what we are going to test just now is the dielectric strength—that is to say, the breaking strain of the paper. If that paper gives out when we suddenly stop the water, then the analogy is, that when we stop the electric current we shall tend to break down the insulation of our cables and any other part of our apparatus. Now I turn on the electric current. By turning the stop-cock I am able to stop it suddenly, and immediately you notice the water escapes through that side tube. If I now open the stop-cock there will naturally be a small leak, through which a very little water trickles; but if I suddenly stop the main flow of water, then the pressure is obviously increased momentarily to a very large extent, producing a spurt of water followed by a steady stream. That is an instructive illustration of the high E.M.F. which is generated when we suddenly break the circuit.

I have been introducing to your notice another analogy—that of rotating bodies—as illustrating a line for the transmission of power or for any other purpose. I will show you now what the dielectric strength of this glass rod is. I have here (Fig. 19) a flywheel, to which I will give a somewhat rapid rotation and then suddenly stop it [*illustrating*], and you see that the dielectric strength of my conductor was not sufficient to stand the strain, and it has broken down. The strain is produced by the momentum of the flywheel—that is to say, by the self-induction of, say, the transformer. I will now put in another rod, and show you how we can prevent these disastrous effects from happening, and that is simply by never breaking the circuit suddenly. By putting in a gradually increasing resistance, the momentum of the flywheel is not able to exert its full impulse instantaneously, and we have a gradual slowing down, and the dielectric is able to stand the strain. To illustrate this, after I have the wheel in rotation, I simply have to grasp it with the fingers and gradually bring it to rest in about a second of time. I have brought it to rest without the slightest undue strain upon the insulation. That means that, with large and powerful plant, in order to prevent the too sudden breaking of the circuit, you ought to have a switch which will enable you to

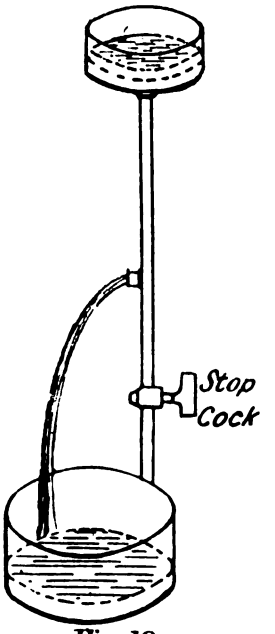

Fig. 18.

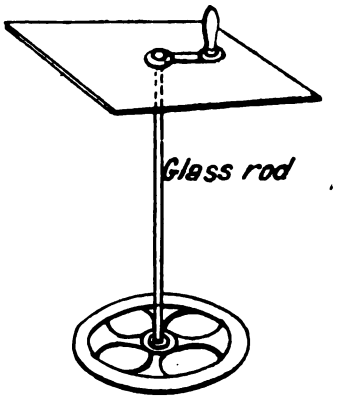

Fig. 19.

gradually insert a resistance before you break the circuit altogether. Then the whole danger to the insulation of the system would be done away with entirely.

Now, I have given you these two analogies because my own experience is that the more analogies we have the greater help it is to us. I know myself that I have gained the greatest assistance from always putting matters into a mechanical form; it assists one to foresee results that may happen, and enables one to apply one's mathematics to it. I do not wish it to be understood that by these analogies one can get rid of mathematics. One can illustrate the qualitative results extremely well, but when we come to the quantitative results mathematics is the true servant to one.

When we are sending an alternating current through a transformer there are two cases that may be considered: one where the power is all being used up, the secondary of the transformer having a full supply of lamps upon it, for instance; and the other where there are no lamps on it, where the secondary is not using up the current at all. In that case there is still a sensible current going through the primary of the transformer, and the question is, What becomes of it? Are we using up a large amount of power in the transformer when the lamps are not on? No, we are not using a large amount; we are using a certain amount. The counter E.M.F. created by the self-induction of the primary of the transformer mitigates this effect when the transformer is doing no work, as then the E.M.F. that is applied to the primary is in opposite phase to the opposing E.M.F. of self-induction. The current, which follows very nearly the impressed E.M.F. when the transformer is doing full work, now, no work being done, lags behind the E.M.F., which still further reduces the power consumed in the transformer on open circuit.

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Now, what is meant by the lag of the current behind the E.M.F.? I have a model here (Fig. 20) which might have been better designed if I had had more time to do it, but it will illustrate what I want to show you. I have a wheel supported on an axis, and I have two weights, one of which in descending causes the wheel to turn in one direction, the other in the opposite direction. What I wish to show you is that when I stop allowing one of these forces to act, the momentum of the wheel will still carry the wheel round in the same direction in which it was going; although an opposing E.M.F. is acting, the wheel continues to rotate in the same direction. You will see the analogy which I wish to be conveyed to you. Now I apply the E.M.F., or weight, on the right, and it sets the wheel in motion. Now I stop it, and you notice that the other weight still goes up for a sensible time—that is to say, the current lags behind the E.M.F. I might put an alternating E.M.F. on first in one direction and then in the other, but the momentum of the flywheel would always be pulling up during a portion of the time against the weight.

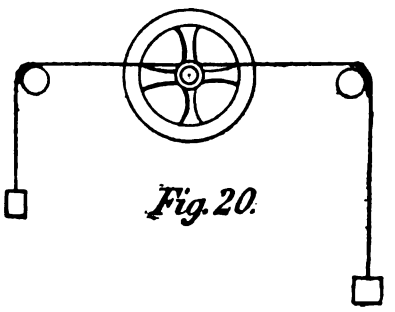

Fig. 20.

Now, I have a very interesting experiment to show you illustrating this lag of the current. It is one which was designed in Prof. Ayrton's laboratory a few years ago by Mr. Smith, and it is a very beautiful experiment. I have here (Fig. 21) two 55-volt lamps connected in series, which will be fed from an alternating source of 100 volts. I shall pass an alternating current through them, and you will see that they light up rather dimly. After that I shall put this high-resistance self-induction coil as a shunt upon one of the lamps, and I shall put on the other lamp a high-resistance non-inductive shunt. Now, the difference between the two conditions of the experiment is this: In the first place, I pass an alternating current through the two lamps in series, and I get a very low illuminating power. I then give a by-path across the one lamp containing self-induction, and a non-inductive by-path across the other, and you will see that the lamps increase in brightness. [*Experiment.*] The reason is that we have to deal with an additional source of E.M.F. besides the main town supply which I am using. This E.M.F. is also tending to set up electric currents, and lags behind the phase of the E.M.F. which is supplied from the mains; consequently we will have these two lamps lighted up by two currents in different phases, and one will attain its maximum when the other is near its minimum. Of course, we do not see this, because the maxima and minima come 150 times a second. So that really by affording by-paths to these two

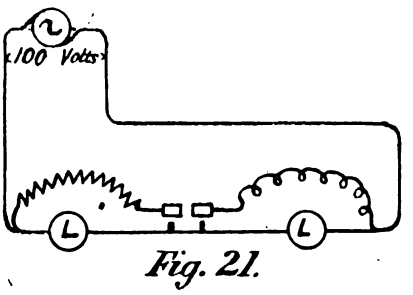

Fig. 21.

lamps we are able to produce a greater illumination than when the whole current is going directly through them. Of course, we are drawing much larger currents from the mains in this case than we were before, but by introducing these coils we are actually able to increase the brightness of the lamps.

Now, the lag of the current behind the E.M.F. is a cause of many curious phenomena, which have been worked out by Prof. Elihu Thomson, of America. Here I have an electromagnet, which I am going to magnetise with an alternating current—it consists of a bundle of iron wires surrounded by a coil, and I will show you that the electromagnet produces a repulsion upon conducting bodies brought into its neighbourhood. Of course, the variations of the electromagnetism due to the alternating current will clearly set up induced currents in a ring or any piece of metal brought near to it. But one would have naturally thought that these currents would be strongest just at the moment when there is no magnetism at all in the core, and that therefore they would act sometimes positively and sometimes negatively, that sometimes there would be repulsion and sometimes attraction, and of equal amounts, and that would be the case if there were no lag in the current. That the reverse is the case, however, is because the current lags behind the E.M.F. induced by the lines of force from the electromagnet. The attraction or repulsion, say, on a ring, at any moment being proportional to the product of the strength of the magnetic field into the strength of the induced current, these former would be of equal amount in an alternation, if there were no self-induction in the ring, and hence no lag, the induced currents being 90deg. later in phase than the magnetic field. But if there is self-induction in the ring, as of necessity there must be, then the induced currents occur more than 90deg. later in phase than the magnetic field, and then the products of the strengths of the two at every moment during an alternation show that there is a

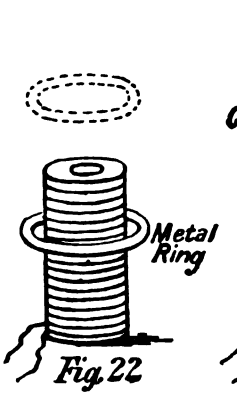

Fig. 22.

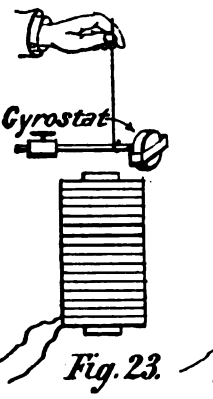

Fig. 23.

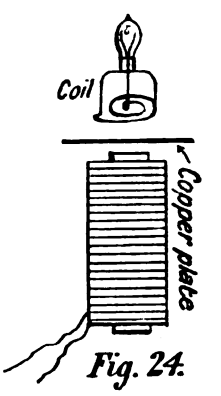

Fig. 24.

marked preponderance of repulsive over attractive impulses; the attraction has become comparatively insignificant. The most striking experiment is with an aluminium ring, because of its good conductivity and lightness, Fig. 22. You see, as soon as I put on the current it throws the ring into the air to a considerable height.

I will now show you the same experiment with a copper ring, which is much heavier, but it is an extremely good conductor. You will see that it will not rise quite so high as the aluminium ring did. [*Experiment.*]

I will now show you that with worse conducting materials the effect does not take place to the same extent. This is a zinc ring, and you will find that it will not rise to so great a height. [*Experiment.*]

I have here a brass ring, which is even a worse conductor still, and it may possibly be able to topple over the edge of the electromagnet, but that is about all. [*Experiment.*]

Here is a ring (Fig. 26) held by two threads to a piece of wood, which I can keep floating above the magnet. [*Experiment.*] The ring, of course, gets intensely hot in a very short space of time, owing to the enormous power that is being expended in it.

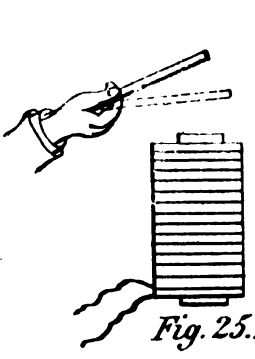

Fig. 25.

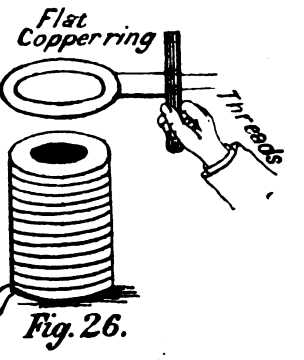

Fig. 26.

There are one or two other experiments I can show you. Here (Fig. 23) we have a gyrostat, which consists of an iron wheel, with a thick copper tyre, which becomes magnetised by the induced currents. The axis is supported on a copper framework that surrounds it, and that causes the lag of the current, which will enable a continuous rotation to be set up in the gyrostat. Here, then, we have an electro-gyrostat driven by this curious force of Prof. Thomson's. He devised a great number of different methods of showing this, from which different results might be obtained. I am able to illuminate this lamp, Fig. 24, but I can screen it off by means of this plate of copper. It is difficult to pass it through because the repulsive force is so great. [*Experiment.*] If that had been a bad conducting material it would not have done it so well, but being a good conductor it screens off the lines of magnetic force and prevents them going through the coil. The lines of magnetic force, instead of going straight up, are bent round.

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Finally, I will show you the effect of trying to bring a plate of copper upon the pole, Fig. 25. I cannot strike the pole: it always rebounds from it owing to the repulsion caused by the induced currents. [*Experiment.*]

NEWCASTLE-UPON-TYNE CORPORATION.

ELECTRIC LIGHTING PURCHASE.

The following is an abstract of Prof. Kennedy's report to the Special Committee on Electric Lighting, presented by that committee to the members of the Council in anticipation of their own report which will be brought up to an early Council meeting.

The report commences by mentioning the two companies in question—viz., the Newcastle and District Electric Lighting Company (hereafter called the lighting company) and the Newcastle-upon-Tyne Electric Supply Company (hereafter called the supply company), and that the area of supply of each company covers the whole town, though, by a friendly arrangement, the lighting company takes the western, and the supply company the eastern sides of the town. Copies of their annual accounts have been supplied by both companies from 1891 to 1894 inclusive, and every assistance has been given to Prof. Kennedy by the officials of both companies in obtaining the facts and figures necessary for this report.

The supply company has an Act dated June 9, 1893, and its term extends for 31 years from July 3, 1891. The works are situated in Pandon Dene, and their present capacity is 800 e.h.p. They supply energy at 2,000 volts pressure over about 11 miles of roads. The authorised capital is £50 000, of which £34 250 is paid up, and £20,000 of 5 per cent. debentures have been issued, making total paid-up capital of £54,250. The total revenue in 1894 was £7,613: the total expenses (without reserve or depreciation) were £4,856, leaving a gross profit of £2,757. The average price per unit sold in 1894 (including meter rents), was 4·56d., and the average cost 2·91d. The company has paid 4 per cent. since 1891, besides writing off nearly half their preliminary expenses. Taking the capital expenditure per lamp fixed, this company stands lowest on the list of 12 given in Table 5—viz., at £2 21. This may be taken as a test of the wise and proper expenditure of capital. The plant and machinery has been kept, and is now, in thoroughly good order.

The lighting company works under an Act dated July 3 1891, and its powers extend for 31 years from that date. The works are situated in Forth Banks and on Virgin Mary leasehold of 65 years from 1866, terminating in 1931. Their present nominal capacity is 1,300 e.h.p., and they supply energy at a pressure of 1,000 volts over about 9½ miles of roads. The authorised capital is £5,000, of which £39,960 has been issued and paid up; £8.900 of 4½ per cent. debentures have been issued, making total paid-up capital £48,860. The total capital expended has, however, been £52,159, or practically the same as the supply company. The total revenue in 1894 (including meter rents) was £8,203, and the total cost (without reserve or depreciation) £4,413, leaving a gross profit of £3,790. The average price per unit was 4·82d., and the cost 2·59d. It is pointed out that the lighting company includes in its returns, not only units sold to the public, but also the units used in the station itself, while the supply company does not. To make the comparison fair, therefore, the quantities used by the lighting company in their station have been deducted in arriving at the figures given above. The reserve and depreciation fund stand at £2,978, while only £500 of the preliminary expenses still stand in the balance-sheet, the remainder having been paid off. Comparing, again, the capital expended per lamp fixed, the lighting company stands at £2·22, and holds the position next to the supply company on the list of 12 companies given in Table 5, so that in economy of capital expenditure the two Newcastle companies stand in the best position. The works and machinery are in thoroughly good order, and with respect to the mains, Prof. Kennedy remarks that they are in exceptionally good order. He has never found mains in more perfect order than those of this company, so far as he has examined them.

Comparing the two companies, their capital expenditure has been practically the same, and they are selling nearly the same number of units per annum, and have practically the same number of lamps on their mains. The lighting company sells slightly more units per lamp and receives slightly more per unit, but the difference is not large. The supply company has slightly the advantage in coal consumption. Both companies in economy of working, as well as in judicious capital expenditure, stand very high indeed among electric works either in private hands or belonging to corporations over the whole of England, and are doing extremely well in comparison with their contemporaries. Their earning capacities are much the same. The price per unit in Newcastle is very low, varying from 4¼d. to 4⅜d., against Bradford, 5·08d.; Leeds, 5·68d.; Birmingham, 6·45d.; Liverpool, 6·82d.; in London the largest companies only get down to 5¼d., and the average London price is much larger. The low Newcastle price, no doubt, hangs on the very low price of gas. While the companies deserve great credit for reducing cost of manufacture so as to enable them to make a profit even at 4¼d., the margin of profit is not enough to allow the stations to pay on a much larger capital expenditure, while it would be practically out of the question for the Corporation, if they took over the work, to charge more for the product.

The report now comes to the question of the financial justification for the Corporation buying, and here Prof. Kennedy's words are quoted verbatim: "This brings me to the point which is of most importance to the Corporation, the point, namely, how far it would be financially advisable for the city to take over the business of the two companies. There is no doubt, that in a number of cases—I may instance Glasgow and Aberdeen among those which have passed through my own hands, Bradford and Manchester among others—the carrying out of electric lighting by a municipality has been financially successful. I have not the least doubt, also, that if the two Newcastle companies could come into the hands of the Corporation with no greater capital expenditure than has actually been incurred by them, it would be a good thing for the Corporation. But this can hardly be the case, unless I have altogether misunderstood the present position of affairs. There is nothing whatever in the Acts of Parliament, nor in the usage of the Board of Trade, which will compel the companies to sell, unless they actually wish to do so. The purchase of the companies by the Corporation can only, therefore, take place as between a willing seller and a willing buyer. Special provisions for early purchase are made in a considerable number of the provisional orders granted by the Board of Trade. I have been enabled, by the courtesy of Sir Thomas Blomfield, to examine all the orders in which this has been done, and if the committee desire it, I could place in their hands copies of all the clauses affecting the matter. In every case the terms approved by the Board of Trade involve the payment of a considerable, although a varying, premium to the companies in addition to their *bonâ fide* capital outlay. It appears also that this is only fair and reasonable for the companies themselves, by hypothesis, must have faced the original risk of failure, and they have as yet only passed through those years of working in which their profits have presumably been smallest. Their shareholders may fairly anticipate that if left to themselves their dividends within the next few years will considerably increase.

"I understand that the Newcastle Corporation can borrow money for electric lighting purposes at such a rate and for such periods that a total of 5½ per cent. per annum would pay interest and sinking fund together. In a case where a corporation commences electric supply works and debits its costs every year, not only with interest on capital, but also with such instalment of a sinking fund as shall wipe the whole capital out in 40 years or less, I do not think it is necessary to debit working expenses with any large special allowance for depreciation, assuming, of course, that all renewals and maintenance of every kind are paid out of revenue as they occur. To find, therefore, the amount of earnings of each of the companies which would be available for payment of interest and sinking fund, I have subtracted from the gross profits in each year an amount of 1 per cent. on the capital, as representing such a depreciation allowance as the Corporation would probably have to make if the works were their own. If the committee think that this allowance is too small, under the conditions I have mentioned, any other figure can easily be inserted in the tables. Line 24 in the tables shows in each case the corresponding net profit—that is to say, the sum which would have been available in each year for the payment of 5½ per cent. on capital outlay if the work had been in the hands of the Corporation itself. Finally, in line 25 of the tables, I have entered the amount of capital on which this net profit would have been sufficient to pay the necessary percentage. It will be seen that in the case of the supply company in 1894 this amounts only to £40,800, although the *bonâ fide* capital expenditure of the company has been £51,752. In the case of the lighting company, interest and sinking fund could be paid on £59,400, as against an actual expenditure of £52,159.

"Taking the two companies together, then, the total capital actually expended has been £103,911, while the net profit (after allowing 1 per cent. depreciation), has been sufficient to pay 5½ per cent. on £100,200."

It would not be advisable for the Corporation to attempt to buy one company and not the other. This could only lead to competition, which must be keen and might be bitter, and it is doubtful whether the Board of Trade would sanction such a course.

"Practically, therefore, under existing conditions, if the Corporation could carry out the work itself with as great economy as the present companies do, it could just pay its way upon the actual capital outlay of the companies. Although I believe that the companies have not yet exactly formulated their desires in the matter of price, I yet understand that they would not sell, for reasons which I have already gone into, except at a very much higher figure than this. It therefore remains to be considered whether the Corporation, if it carried out the work itself, could effect any considerable economy in cost of working, and, further, what advantage to the city, especially in the matter of public lighting, might accrue from the fact of the electric light works being in the hands of the municipality."

There is one way by which the Corporation might economise—viz., by so connecting the two stations that one only need run continuously, the other supplying current during the time of heavy load only. This is electrically possible, though there are practical difficulties, and some considerable expense would be involved in carrying it out. It might result in a saving of working expenses of perhaps £1,200.

"Of course, in putting the matter in this way, I assume that the costs of management under the Corporation would remain as small as they are at present. I am not all sure, however, that this is a safe assumption, for certainly just now no money is wasted in this matter, and the only outlay which would obviously be saved is the directors' fees, amounting altogether to no more than £341 per annum in the two companies. But unless I am mistaken, this sum by no means represents the real value to the companies of the services of certain very able gentlemen who

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have taken, and still take, a very active share in their development and management. In all probability the Corporation would have to pay a much larger sum for any equivalent services, and the total saving I have mentioned would be much reduced."

One important advantage the Corporation would gain would be in street lighting. Arc lamps might be more fully used At present there are about 20, which might be advantageously increased to 100 or more It would be fair to reckon the cost of such lamps at about £23 per annum, as against £42 now paid, which should include interest and redemption on capital specially raised for such lighting. The 80 additional lamps suggested would displace 360 gas lamps, and reckoning all savings, the additional cost would amount to about £520 per annum, or £6. 10s. per lamp. which is much less than the usual additional cost of street electric lighting; but in other places the lamps are seldom more than 60 yards apart instead of 90 yards, as in Newcastle.

Here, again, it is necessary to quote verbatim: "I think it is right that I should point out a further matter to you, in reference to the probable cost to the city of taking over the present works Although, undoubtedly, the works of the two companies are in such a state that they may be run by the companies themselves with very little additional expenditure beyond the annual outlay on additional plant and mains which I have already dealt with, yet I doubt very much whether the Corporation would be content to carry the work out in the same way. The buildings, for instance, of the lighting company, and the very crowded state of their station, would probably appear to a committee of the Corporation to demand radical change, although the company itself may quite well make them last a long time. The same remark may apply, in my opinion, to the mains (although not to the buildings) of the supply company, although there the additional capital expenditure would not be large. It is in the nature of things impossible for me to put before you any absolute figures which should represent the probable additional capital expenditure under such heads as these; but I think it is almost an universal experience in such cases that a transfer of property, whether to a corporation or otherwise, will almost certainly be followed by really large alterations and modifications under such circumstances as I have indicated.

"It appears from the considerations given above, that if the Corporation took over the work of the two companies it might, by running the stations jointly, economise in cost of running, and that it certainly could considerably increase the street-lighting at a cost to the municipality which would be very small. There still remains the crucial point, whether the actual economy and convenience would be sufficient to justify the Corporation as a matter of business in buying up the companies.

"I have pointed out that, taking the actual figures for the working in 1894, it might be possible for the Corporation to have done the same work for an amount of £1,200 less than it has actually cost the two companies together.

"I may say at once that I doubt very much indeed whether the Corporation actually could secure the whole of this saving, for many reasons, some of which I have indicated, but for the present purpose I will suppose that the saving can be obtained. This would raise the gross profit of the two stations together to £7,747,* the capitalised value of which at 6 5 per cent.—namely, 5·5 per cent. for interest and sinking fund, and 1·0 per cent. for depreciation—is, say, £119,000, or about 14·5 per cent more than the actual capital expenditure of the two companies. But against this has to be set the fact, which I have felt bound to bring before you, that apart altogether from any question of premium, and from all question of additional capital required for normal extensions, the Corporation would almost certainly find themselves involved in considerable additional capital outlay. This would swallow up a not inconsiderable portion of the 14·5 per cent., and would certainly not leave the possibility of paying any such premium as the companies may not improbably, and not improperly, desire.

"It does not, however, follow that what is true in 1894 fairly applies to the conditions which will exist in the course of a few years, when the business has largely increased. With the object of estimating the probable prospects in this direction, I have collected the figures given in Tables 1 to 4, and have very carefully studied them, both in the tables and in their graphic present ment in the accompanying diagram. I am sorry to say that I have found found myself driven to the conclusion that it could not pay the Corporation to purchase the works and goodwill of the two companies at any price covering a premium approximate to that which has been suggested by one of them. I have arrived at this conclusion in several different ways, the details of which it is unnecessary that I should state at length. The following figures, however, indicate generally one of the lines of reasoning which I have followed out: The actual capital outlay of the companies has increased fairly regularly year by year. and I do not see any sign that this rate of increase is going to diminish. It is true that the supply company expect to be able to increase their output somewhat by replacing the dynamos, and driving the present engines at a higher power This however, will not go very far, and both companies have their present buildings fully occupied by their present plant. and will soon be compelled to extend, while the supply company will soon have to purchase its land. The mains also, as well as the expenditure in transformers and meters, must increase continually as new consumers come on. The total revenue bears an approximately constant ratio to the capital expended, which ratio may be taken as about 15·25 per cent. It seems to be rather diminishing than increasing. The mean ratio of working expenses to total revenue was, in 1894, 58 8 per cent. If the Corporation had been carrying on the work of 1894, and had been able to effect the whole of the saving above assumed. this ratio would have fallen to 51 per cent. From the tables it will be seen there is no indication of this ratio falling very fast, although no doubt, it will fall. In an extreme case, which has not yet been reached by any corporation or company in Great Britain. I may assume that the total costs are presently reduced to 2d per unit sold, which would be, say, 44 per cent. of an average price of 4½d. per unit. so that the cost would be 44 per cent. of the revenue.

"Taking, then, the revenue as being 15 25 per cent. of the capital expended, and the total costs as reduced to 44 per cent. of the revenue, there would be left as gross profit an amount equal to 56 per cent of the revenue, or about 8 5 per cent. of the normal capital; 5·5 per cent. is required for interest and sinking fund and 1 per cent. for depreciation, or 6 5 per cent. in all. so that the calculated gross profit would be sufficient to pay this percentage on a capital increased in the ratio of 8·5 to 6 5. or 30 per cent. In other words, if the Corporation were to buy up the companies at their present capital expenditure. plus 30 per cent; if it incurred no further capital expenditure of its own beyond the normal rate of increase; if it realised a far greater economy in working costs than has been attained by either of the companies, or, indeed, by any other company or corporation throughout the country as yet. it might just succeed in making the scheme pay its way, with the allowance for interest, sinking fund and depreciation which I have mentioned. I feel, on the one hand, more than doubtful whether the assumed reduction in costs can be reached (considering how economically the companies are now working), and, on the other hand, I feel sure that there would be considerable additional special capital expenditure, so that as a matter of safe finance I cannot think that it would be possible for the Corporation to buy up the companies if anything more than a nominal premium were to be asked. Obviously, if the purchase were made, the premium would have to be different in the two cases. As to what is reasonable in this respect, from the point of view of the companies, I have already expressed my opinion.

"As my final conclusion in this matter may seem at first sight to be at variance with the very successful results obtained by various corporations in working their own electric lighting works at a profit, I may point out once more that the whole difficulty arises from the low price charged per unit. (I have here taken the 6d. as including meter rentals.) If the Corporation could increase the price to 6d. per unit (as they are entitled to do by Act of Parliament), the whole difference, amounting to about 30 per cent. of the gross income, would go to net profit, and would increase the present capitalised value of the companies, at 5·5 per cent., from £100,200, as given in paragraph 28, to about £190,000. I cannot suggest to the Corporation that they should raise the prices, for I presume this is practically out of the question, but I emphasise the matter again, because it is really the key of the whole position."

The refuse destructor is touched on as a source of power. but the saving in coal would not justify a third station and new mains, and the report concludes as follows: "I am very glad to acknowledge here the cordial and courteous help which I received throughout my investigations from all the officials of the companies, and the very full way in which they have given me the information for which I have found it necessary, in your interests, that I should ask. "ALEX. B. W. KENNEDY."

Table 5 is appended. The remainder of the tables and diagrams, while extremely valuable, are too bulky to print *in extenso*. The information is of more value as a record than of public interest, and the companies might reasonably object to the publication of so minute an analysis of their business.

TABLE 5.—Capital per Lamp Connected.

Company or corporation.	Capital.	No. of 8-candle lamps connected.	Capital per lamp connected.
Metropolitan (1893)	£585 932	166.000	£3·53
St. Pancras (1893)	96,085	30.326	3·17
Brighton	119 382	38 249	3·12
Manchester	127,985	42 635	3·00
Leeds	64,118	21 720	2 95
Bournemouth	40,536	14,552	2·79
Cambridge	31,503	11,644	2·71
Chelsea	119,705	47 286	2·53
Westminster	411,019	167,703	2·45
Glasgow	120,978	53,156	2·28
Newcastle (Lighting Co)	52.159	23.520	2·22
Newcastle (Supply Co.)	51,752	23,430	2·21

* "There is nothing to add to this for the arc lighting, for I have assumed that this is done at its actual additional net cost, in which, therefore, no profit would be covered."

LEGAL INTELLIGENCE.

ALLEGED BREACH OF LICENSE.

We hear that the Edison and Swan Company have commenced legal proceedings against a leading electrical firm, who are one of their licensees under the company's holders patents, for breach of the license in giving to customers a larger discount than the allowed maximum. For some time past there have been rumours that some of the licensees were selling holders at a lower price than that fixed by the company under the terms of the license, and that recently a committee of the licensees has been formed in order to

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establish "an honourable understanding" among the licensees that this underselling should be discontinued. The terms of the license are very stringent—viz.:

"The licensee shall not make or allow any discount, commission, rebate, return, gift, or allowance to customers greater than the discount from time to time allowed by the company."

The Edison and Swan Company gave notice on December 31 last in a circular letter that should any future breach of this condition be proved that they would take legal proceedings for an injunction and for damages. It is for the good of all the licensees and for the trade generally that the terms of the Edison and Swan license should be maintained, and it may be hoped that the legal proceedings which are now being instituted will put an end to any unfair advantage being taken by some of the licensees against others.

COMPANIES' MEETINGS AND REPORTS.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

The ordinary general meeting of this Company was held on Wednesday at Winchester House.

Sir John Pender, M P., presided, and, in moving the adoption of the report, stated that the receipts for the half-year ended December 31 last had been £104,926, or £10,247 in excess of those of the previous half-year. The total charges for the half-year had been £36 772, showing an increase of £16,503, which was owing to the fact that heavy expenditure for repairs of cable and renewing both shore ends at Pernambuco fell upon the half-year under review, while there were no similar expenses in the previous six months. Taking both receipts and expenses into account, there was, after providing for income tax, a net profit for the December half of £61 822, showing an increase over that of the June half of £2.029. As usual in the first half of the financial year, two quarterly interim dividends at the rate of 6 per cent. per annum had been paid leaving £24,324 to be dealt with. The directors had transferred £20,000 of this amount to the reserve fund, and they carried forward the balance. The reserve fund now amounted to £722,000, but a strong reserve was absolutely necessary for such a company as theirs. The directors were endeavouring to make satisfactory arrangements with the Brazilian Government, whether the latter acquired the coast cables or not, for the working of the traffic, in a way beneficial to both the Government and the people of Brazil and to telegraph companies also. The lines of the Pacific and European Company, in which this Company was largely interested, had now been opened for a year, and had worked with satisfactory results. The sum of £55,660 appeared in the balance sheet as paid for 5,566 shares of £10 each in the Azores Company, which might eventually connect the present system with the North American continent. After referring with great regret to the death of Mr. Fuller, the late managing director, he stated that when the question of the purchase by the Government of the cables of the Western and Brazilian Company was disposed of the Brazilian Submarine Company would have to deal with the Brazilian Government, with whom, for 21 years of their existence, they had worked in the most friendly relations. If any Government wanted to maintain a thoroughly efficient system of submarine telegraphy they must act in touch with the companies who conducted it, and the different companies ought to act always as one.

Mr. Brodrick, M.P., seconded the motion, which was unanimously adopted.

CHINA AND JAPAN TELEPHONE COMPANY.

The ordinary general meeting of this Company was held on Tuesday at the offices, Austin Friars, Mr. H. Grëwing presiding.

In moving the adoption of the report (which stated that, after charging debenture interest, the revenue account showed a credit of £387), the **Chairman** remarked that the amount received for subscriptions had been better than in the previous year, and in so far the Company was making steady, though slow, progress Owing, however, to various circumstances partly through the war, and partly on account of epidemics—the sales had fallen off to some extent, as had also the profits, which were also adversely affected by the decline in exchange. It was hoped, however, that these matters would rectify themselves in view of the recent rise in silver and the conclusion of the war. China had so far not taken any more kindly to telephones than it did in former years, but now that the war had changed the condition of things, the Chinese might alter their views on the subject, and might come under the Company's exchanges.

Mr. Thomas Lloyd seconded the motion, which was carried.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.

The report of this Company for the second half of 1894 states that the amount to credit of revenue was £33,243, against £34,265 for the corresponding half-year of 1893, and that the expenses have been £23,613 against £22,602, leaving a balance of £9 629, which, with £2,850 brought forward, makes a total of £12,479. It is proposed to pay a dividend of 6s. per share on the first and second preference shares, and to carry £710 forward. The traffic receipts show a decrease of £1,948 compared with the corresponding period, and those for the current half-year show no improvement. The cost of repairs to cables during the half-year amounted to £10,501, being £952 more than that for the corresponding period, and the contract with the French colony of Guadeloupe expired on December 31, so that the colony's subsidy of £2,000 per annum is no longer payable. These and other losses of revenue have rendered the payment of any dividend on the ordinary shares impracticable.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Oldham.—The Corporation Electric Light Committee require tenders for supplying two 200-h.p. steam-engines and dynamos, steam-pipes, etc. Specifications and forms of tender may be obtained on application to Mr. Arthur Andrew, Gas and Water Offices, Oldham, to whom tenders are to be sent, endorsed "Tender for Engines and Dynamos," on or before the 28th inst.

Hanley.—The Corporation invite tenders for the supply, delivery, and erection complete of two Lancashire boilers and fittings, including steam receiver; water-tank and girders; arc lamps and posts; high and low pressure cables, street boxes, cast-iron pipes, etc., in certain streets in the borough; transformers, switches, etc. Forms of tender may be obtained, and specifications and plans inspected, at the office of Mr Joseph Lobley, borough engineer and surveyor, Town Hall, Hanley. Tenders must be sent in to the borough engineer before the 27th inst.

Brighton.—Tenders are invited by the Corporation for (*a*) the preparation, supply and delivery at Brighton of cast-iron lamp pillars and copper canopies for electric light arc lamps; (*b*) the preparation, supply, and delivery at Brighton of cast-iron and drawn-steel bracket posts for suspending electric light arc lamps. Drawings may be seen, and specifications and forms of tender obtained, at the office of the borough engineer and surveyor at the Town Hall, Brighton, on payment of £1. 1s. for each specification. Sealed tenders, addressed to Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton, and endorsed "Tender for Cast-Iron Lamp Pillars" or "Tender for Iron and Steel Bracket Posts," must be sent to the town clerk's office at the Town Hall before 10 a.m. on May 27.

BUSINESS NOTES.

Walsall.—The Town Council has agreed to a recommendation of the Property Committee that the Town Hall be illuminated by the electric light.

Hampstead.—The electrical engineer to the Hanley Corporation, Mr. G. H. Cottam, has been appointed chief electrical engineer to the Vestry.

Train Electric Lighting—The London, Tilbury, and Southend Railway Company have adopted a capital improvement in lighting the carriages of their trains by electricity.

City and South London Railway.—The returns for the week ending May 12 were £832, compared with £905 for the corresponding period of 1894, being a decrease of £73.

Rhyl.—The Urban District Council has received an application from a Birmingham firm asking for permission to construct an electric railway between Rhyl and Prestatyn.

Wells.—A tender from Mr. Dixon Brown, for publicly lighting the city by electricity, at £350 per annum, has been accepted by the Corporation for three years from June, 1896.

Southport.—Circulars are being issued by Mr. Ellis, the borough electrical engineer, setting forth the probabilities of a considerable abatement shortly in the price of current supplied.

Penistone.—The Board of Guardians have resolved to accept the offer of Messrs. Pettitt and Hards to send in specification and scheme for the supply of electric light to the workhouse.

Concert—The City Electric Light Athletic Club held a very successful Bohemian concert on May 11, at the Three Lords' Hotel, Minories, E C. The chair was taken by H. F. Jackson, Esq.

Brechin.—A communication has been read to a meeting of the Police Commission from the Board of Trade intimating that they were not to proceed with the Brechin electric light provisional order.

Fairfield (Buxton).—The Urban Council has agreed to a proposal to form a lighting committee to take into consideration the question of lighting the district, and to make enquiries respecting the electric light.

King's College.—The annual dinner of old students of King's College, London, will be held at the Holborn Restaurant on Monday, June 24, with the Right Rev. the Lord Bishop of London, D.D., in the chair.

Buenos Ayres—The Government have contracted with Messrs. Bonison and Mautalen for the construction of a building for the electric light station for the illumination of the port works. The cost is put down at 49,450dol.

House Installation.—We are informed that the Duke of Montrose has placed the electric lighting of his new house in Pont-street, London, in the hands of Messrs. Drake and Gorham, of Westminster. The number of lights will be about 130.

Taunton.—The Electric Lighting Committee of the Town Council has reported that Prof. Fleming, D.Sc,, had visited the town, inspected the electric light works, and made many valuable suggestions, which he promised to embody in a report.

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Consolidated Telephone Construction and Maintenance Company.—The directors recommend a dividend at the rate of £1. 10s. per cent. per annum, less income tax, for the year ended March 31 last. The transfer-books will be closed from the 18th to the 21st inst., both days inclusive.

Milver Portable Electric Battery Syndicate, Limited.—This Company has been registered with a capital of £20,000 to acquire certain patents and inventions relating to improvements in primary batteries, and to develop and turn to account the same; and as engineers and electricians generally.

Worcester.—The clerk to the Town Council reported that with regard to the lighting of Stanley-road, Vincent-road, and Cecil-road, the Electricity Committee were awaiting the result of an experiment with incandescent lamps in Friar-street before proceeding with the lighting of other streets.

Ipswich.—The Electric Lighting Committee of the Town Council, for economic reasons, recommends that on further steps be taken to obtain a provisional order for electrically lighting the borough; and that Prof. Kennedy, who visited Ipswich on several occasions, be paid 100 guineas for his report.

Windsor.—The clerk to the Urban District Council has reported that the provisional order has been granted by the Board of Trade with reference to the electric lighting of Windsor. He added that the only thing required now was the sanction of Parliament, and when that arrived it would be duly advertised.

Glasgow Electric Lighting Revenue.—Up to April 24 the amount collected in electric lighting rental was £15 528, as compared with £13 364 over the corresponding portion of the preceding financial year. In this branch of the lighting department there was an increased revenue, which amounted to £2,164

Bootle —The Town Council have passed a recommendation of the Electric Lighting (Special) Committee that the electric light installation in the Town Hall and adjacent buildings be placed under the control of the Parks and Baths Committee, and that the Electric Lighting (Special) Committee be dissolved.

Dover.—Preparations are being made to lay an electric light main to the turret of the Admiralty Pier, where the current not only will be used to illuminate the turret and engine-room, but, in addition, will work a powerful search-light. A dynamo will also be placed inside the turret machine-room in reserve.

Metropolitan Asylums Board.—At a recent meeting the Brook Hospital Committee were authorised to employ Prof. A. B. W. Kennedy, LL.D., F.R.S., to design the installation of the electric lighting of the Brook Hospital, and to draw the necessary reports, plans, and specifications, and supervise the execution of the works, at a commission of 5 per cent. on the cost thereof.

Derry.—The Lighting Committee of the Corporation has accepted Messrs. Siemens Bros.' tender for carbons, samples of which were received from various firms. They cost the Corporation about £300 a year. It was agreed that the experiment made by Mr. Christie in lighting the City Hall clock by electricity with the ultimate view of lighting it permanently in that way was a success.

Northampton.—The Highway and Lighting Committee of the Town Council has recommended that the Market-square be lighted with four electric lamps of 1,000 c.p. each (two to be switched off at midnight), at an annual cost of £70, in accordance with the estimate of the electric light company, but after a long discussion an amendment, referring the matter back, was carried by 13 votes to 7.

County of London Tramways Syndicate, Limited.—This Company has been registered by Ashurst and Co., 17, Throgmorton-avenue, E.C., with a capital of £5,000 in £10 shares. Its object is to establish, construct, and maintain rail and tram roads, electric lighting, and other works, and to carry on the business of general contractors for public or private works in any part of the world.

Cardiff.—Several sums in the expenditure of borough account have been marked down as arrears which should have come into previous estimates by a special revising committee appointed by the Cardiff County Council. A sum of £800 was set down for lighting the Town Hall by electricity, and it was decided to apply for borrowing powers with respect of £300 as well as for £400 for lighting the market by electricity.

Worcester.—The Electricity Committee of the City Council have reported having arranged with the Streets Committee for the use of the London-road weighing-machine house as a transformer-chamber, and that arrangements have been made for the police institute to be used as an office for the electrical engineer, and the Council were recommended to authorise the office being connected with the electricity mains for testing purposes.

Aberystwyth.—The Public Lights Committee of the Town Council has recommended that the Council should avail themselves of the services of Mr. A. H. Preece, C.E., in the matter of testing the electric light and other matters connected with the proposed installation. The recommendation was passed. A recommendation of the Public Works Committee regarding the erection of electric lamp-posts at a cost of £900 was also accepted.

Mechanical Ventilation in Steamships.—The Russian Steam Navigation Company having been so satisfied with the efficiency of the "Baird-Thompson" improved system of mechanical ventilation introduced into their fleet some time ago, they have contracted with Messrs. Baird, Thompson, and Co., Limited, of London and Glasgow, for the introduction of their system into the large new steamers at present being built for them in this country.

Mill-Lighting.—A complete installation of 1,200 lights is being fitted in the Valley Mills of Messrs. James Nelson and Co., of Nelson, Lancashire. The installation is being carried out by Messrs. Coates Bros., of Nelson. The dynamos are being built by the Coventry Electrical Engineering Company, Limited. There will be two 600-light dynamos and one 250-light dynamo. The 600-light dynamos will be driven by ropes from the main shafting, the 250 light dynamo by a separate engine.

Cheltenham.—At the last meeting of the Town Council, Alderman Norman, in moving the adoption of the minutes of the Electric Lighting Committee, said he had very little doubt that within a short time the electric light would not be the slightest burden on the town. The largest item in the accounts was the £3,500 to be paid to Messrs. Siemens, the contractors. They still held one-fourth of the amount due to the contractors until the machinery had been running the specified time.

Church Electric Lighting.—The Dover Electricity Supply Company has received a letter from the vicar and churchwardens of Buckland Church, Dover, in which they say that after a month's trial of the electric light in Buckland Church the result exceeds their most sanguine expectations, and from whatever point it is compared with gas it is found well ahead. For the three months ending March 31 the cost of gas was £3. 18s. 3d., while with electricity, based upon the consumption during the last month, it would have been £3. 5s. 1d.

Appointment Vacant.—The Corporation of Tunbridge Wells require a resident engineer to take entire charge of their electric lighting works. Applicants must have had experience of similar work, must be capable of superintending additions and extensions of the works, and the person appointed will be required to devote the whole of his time to the performance of his duties. Salary £250 per annum. Applications, stating age and experience, and accompanied by copies of three recent testimonials, to be sent to Mr. W. C. Cripps, town clerk, Town Hall, Tunbridge Wells, by the 25th inst.

Blackpool.—The Town Council have decided, upon the recommendation of the Electric Lighting and Tramways Committee, that the rectifying apparatus be retained by the Corporation, subject to a guarantee by Messrs. S. Z. de Ferranti. Further decisions were to the effect that 4½d. per unit be the amount charged the Corporation until further notice for public arc lighting in the borough; and that the necessary cable to complete the Church-street district lighting be procured under the directions of the chairman (Councillor Pearson), Mr. Hammond (consulting electrical engineer) and the borough electrical engineer.

Bangor.—At the last meeting of the City Council, Dr. Grey Edwards proposed the appointment of an electric light committee. They hoped shortly, he said, to receive the report of the Edison-Swan Company, and it would be very advantageous to have a committee to go into the question thoroughly. They had already authorised the Water and Gas Committee to obtain the services of an electrical engineer to go into the question of plans and estimates. He thought it was necessary to proceed at once and to decide whether they would relieve the gasworks by the addition of electric light in the city. After some discussion a committee was formed.

Stroud.—The clerk to the Urban Council has received a letter from the district manager of the National Telephone Company in reference to the scheme to place Stroud in direct telephonic communication with Gloucester, Bristol, and other parts of the country. The letter pointed out that the scheme would involve a very large expenditure, by no means fully covered by the preliminary subscribers, and the company, therefore, relied upon the support of the Council in furtherance of the scheme. Plans accompanied the letter with the suggested position of the poles necessary to reach certain points to be connected. The Council accepted the company's plans and terms of agreement, subject to certain protective regulations.

Leyton (Essex).—The Hall Building Committee of the Urban Council has reported that the estimated cost of lighting the public hall by electricity is £1,250. The committee were of opinion that the buildings, including the present offices, should be lighted by electricity, and they recommended that tenders be invited from several firms. Mr. Trumble complained that in connection with the new hall they were always having extras sprung upon them It was now suggested that they should have electric light at a cost of £1,250, or £1,000 more than was allowed for lighting in the specification. He moved that the report be referred back to the committee, and that details be presented at the next meeting. Mr. Dick seconded this, and it was carried.

Bowness.—At the last meeting of the Urban District Council the clerk read the agreement between the Council and Messrs. R. H. Fell and Sons, in the matter of lighting the village by electricity. The agreement stated that the Council should pay 25s. per lamp per annum, the company to rebate £20 from the charge, this money to go to the payment of an inspector. The company would supply 35 new lamps of 25 c.p. for the main road, the rest of the lamps to be 16 c.p. The company were further required to keep the lighting system in working order to the satisfaction of the Council, so that there should be no interruption to the lighting, and to pay 1d. per hour for any that were not lighted. Only the incandescent lamps and globes were to be paid for by the Council. The agreement was sanctioned by the Council.

Killarney.—The Clerk to the Town Commissioners stated at a recent meeting that some time ago they passed a resolution directing him to write to the Board of Trade to know who the officers of the electric light company were, and the Board's reply was as follows: "In reply to your letter of the 27th ult., I am directed by the Board of Trade to inform you that Mr. George Pearson, of her Majesty's Treasury, Whitehall, London, S.W., is

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the auditor appointed by them to audit the accounts of the undertaking authorised by the above-mentioned order, and that Mr. James Downes is the secretary of the Killarney Electric Light Company, Limited. I am further to inform you that the accounts of the undertaking for the year 1892 and 1893 have been audited by Mr. Pearson." The Chairman remarked that some outside people seemed to think that there was no electric light company at all.

Liverpool.—The report of Sir Frederick Bramwell, the expert who had been engaged to examine the plant and other property of the Electric Supply Company, Limited, on behalf of the Corporation, has been presented to the Special Lighting Committee of the City Council. It described the condition of the whole of the machinery and appliances. The conclusion to which Sir Frederick arrived was that everything was satisfactory, and that the purchase would place the Corporation in possession of a valuable property. Mr. Harcourt E. Clare, the deputy town clerk submitted the draft of the agreement with the company, which was considered. Its adoption is subject to the approval of the Electric Supply Company. The total amount of the purchase is £400 000. The committee decided to retain the services of Mr. Holmes, the managing engineer of the company, at the salary he is now receiving.

Hove.—At a meeting of the Urban Council, Mr. Usher Robins directed attention to the charges of £793 for gas and £47 for the electric light, making an expenditure of nearly £1,000 for the quarter. He thought now that the electric light company had been in existence for about three years it was time the Council had some information from the committee as to which they considered the best mode of illuminating. Mr. C. T. Cheesman, in reply, said the committee, or rather the surveyor, was preparing a report relative to the cost of the gas and of the electric light. At a subsequent meeting of the Library Committee, Mr. Usher Robins said he thought the whole of the inhabitants would be benefited if the electric light were more generally used. He was glad to know that they would shortly have a report as to electric lighting. Captain Creagh said if they burned the electric light for four hours out of the 24 they would pay exactly double the amount charged to people living in Brighton. The Corporation of Brighton charged 4d. per unit, and they paid the company in Hove 8d.

Western and Brazilian Telegraph Company, Limited.—The report of this Company states that the total earnings during the second half of 1894 amounted to £82,815. against £80,338, showing an increase of £2,476 compared with 1893, and that the working expenses amounted to £36,403, against £35.592 Including the amount brought forward and dividends received, the balance was £56,660, from which has been deducted £11,601 for debenture interest, and £5 000 for the debenture redemption fund, leaving £40,059, of which £8,000 has been placed to the reserve fund The directors now recommend the payment of 6s. per share, tax free, for the half-year on the ordinary shares, making, with the dividend paid in November, £3 per cent. for the year, leaving £2 846 carried forward. In the case of divided shares, 4s 6d. will go to the "preferred" shareholders and 1s 6d. per share to the "deferred" shareholders. The Company's action against the Brazilian Submarine Company was heard on March 8, and decided on all points in the Company's favour. Six thousand pounds per annum is now being paid by the Brazilian Submarine Company.

Perth.—About a month ago, at a meeting of the Waterworks Commissioners, Mr. Davidson, the manager, produced a scheme and cost of lighting the works with the electric light, and the Commissioners agreed to allow him to proceed with the work. Contracts were taken and the offer of Messrs. Lowden Bros., of North Tay-street, Dundee, was accepted. The contractors have now completed their work At the inauguration of the light, Lord Provost Dewar said they had better light, more of it, and at less cost than gas It was also interesting in so far that, as that was the first installation of the electric light in the public departments in Perth, he believed it would be the beginning of a further extension of it. Mr. Davidson said that he would be able to give them enough power to light their new municipal buildings; while the electrical engineer said that the water at present running to waste at the foot of Mill-street could also produce enough power to light the municipal buildings. Mr. Davidson stated that at present there was enough power running to waste at the City Mills which would light a large portion of the streets and also the public library.

Ulverston.—Mr. John Poole, as clerk to the Ulverston Urban Council, has been granted an interview by the Rural District Council on the subject of electric lighting. He said they would be aware that under the agreement between the Windermere District Electric Supply Company and the local authorities interested power was given at the end of 10 years to purchase the distributing arrangements of the company upon the terms set forth in the agreement. The Board of Trade had, however, in the order sent down for their approval, inserted certain words to the effect that no sale under this purchase clause should be valid or binding unless the consent of the Board of Trade was given thereto. So far as the Ulverston Urban Council was concerned it had already passed a resolution objecting to the purchase being subject to the consent of the Board of Trade, and Mr. Tosh, the chairman, had arranged to see the Board of Trade on the subject in London. He (Mr. Poole) had written to this effect to Mr. Morse, the solicitor of the Electric Supply Company, who had replied that he did not think there would be any difficulty in getting the Board of Trade to omit the objectionable words. He had laid the matter before the Rural District Council, in order that they might consider whether they should not pass a similar resolution. Councillor Marshall moved a resolution objecting to any modification of the agreement made by the company in the sense of restricting the power of free sale between the company and the Council. The motion was agreed to.

Eccles.—The Town Council have confirmed the proceedings of the Electric Lighting Committee which included reports of the visits they had made to Wolverhampton and Altrincham. At the former they were met by the Mayor of the borough, who is chairman of the Lighting Committee, several members of the committee, the electrical engineer, and the town clerk, and were very courteously treated, it appearing to be the desire of everyone connected with the Wolverhampton works to impart all information in their power, in order, as they said, to enable other corporations treading in their footsteps to put down as complete and perfect a station as possible On April 30 the committee, accompanied by the engineer (Mr. Clirehugh), and the town clerk, proceeded to Broadheath, to inspect the station established by the Altrincham and Bowdon Electric Supply Company, Limited, who had recently undertaken the lighting of the district. Mr. Fawcus and Mr. Cowan, of the Manchester Edison Swan Company, and the engineer met the committee, and explained the system, and also exhibited a map of the area of supply, from which it was seen that the undertaking has all the difficulties to contend with of a sparsely-populated area, consumers being in some cases few and far between.

Weston-super-Mare.—The following report has been laid before the Urban Council: "It will be remembered that your Local Board, some time since, went to the expense of nearly £500 to obtain a provisional order, by which they monopolised the power to introduce electric lighting into Weston super-Mare within a given period. The powers secured under such order have never been utilised, the representatives of the ratepayers being content to watch the expensive experiments that have been made by other towns. I have repeatedly asserted that the 'light of the future' is not yet perfected, and the longer the adoption of any particular system is delayed the better will it be from a financial point of view. There are those, however, who appear anxious to rush the matter at any cost, holding up as a bugbear the possibility of a private company stepping in and usurping the powers hitherto enjoyed by your governing body. Public companies, however, as a rule are not so rash as to expend their capital without some prospect of a remunerative return. If an electric lighting company should determine on making Weston super-Mare the basis of their operations it is not probable that your Council would hand over the public lighting to their care and without this the revenue from private consumers would make a sorry return on the investment. Your Council have now as much as ever the entire matter in their own hands, and a renewal or extension of the provisional order, now expiring, will tide them over a difficulty which just now is being considerably magnified."

Islington.—In a report issued on Wednesday by the Finance Committee of the Islington Vestry they submit to the Vestry a correspondence which has passed between the vestry clerk and the comptroller of the London County Council with reference to a loan of £51,000, which the Vestry require for electric lighting purposes. It is stated that the Finance Committee of the Council, having obtained the consent of the Treasury, are prepared, as an alternative to their proposal, to sanction the loan for land, buildings, and bare copper mains (estimated to cost £18 000) for 50 years, and for all other machinery (estimated to cost £33,000) for 20 years, to recommend the Council to sanction a mean period of 42 years for the repayment of the whole amount "on condition that if any portion of the machinery requires to be renewed during this mean period, it shall not be made the subject of a new loan." The Vestry's committee point out that acceptance of this condition would render it necessary, besides providing for the annual repayment of capital and interest, to further burden the undertaking (or possibly the ratepayers) during its earlier years by the creation of a renewal fund to provide not only for the wearing out of machinery, but for the possibility, owing to the advance constantly taking place in electrical science, of portions of such machinery becoming obsolete during the currency of the loan. Further, it is considered doubtful whether the Council, in sanctioning a loan, has power to limit the period for repayment provided by Section 8 of the Electric Lighting Act of 1882, and Section 190 of the Metropolis Management Act, 1855. Hence, the Vestry's committee advise that counsel's opinion be taken on this point, and meanwhile the vestry clerk make a formal demand for the County Council's sanction to the loan.

Brighton.—At a recent meeting of the Town Council, Alderman Brigden proposed the confirmation of the committee's proceedings of April 26, withdrawing the resolution as to the acceptance of a tender for the extension of the electric generating station. The motion was negatived. This referred to the six tenders which were received for the extension of the Corporation electric generating station, and it was resolved to accept that of Messrs. J. Longley and Co., Crawley, for £12,169. At a meeting of the Lighting Committee it was resolved that the electric lamp-pillars for the lighting of the Marine-parade be of similar designs to those at present on the King's-road, and that tenders be invited by public advertisement for the supply of 45 such pillars. A design submitted by the borough surveyor for the lamp-pillars to be erected in the other streets which are to be lighted by electricity was approved, and it was decided to advertise for tenders to supply 80 such lamps. A design for the canopies of the electric lamps to be erected on the Marine-parade has been approved, and it was resolved to advertise for tenders. The question of increasing the lighting in Regency-square was deferred for the present, in view of the possible extension of electric street-lighting. These recommendations were adopted. On the 10th inst. the report of

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the Works Committee, recommending, after further consideration of the tenders for the extension of the electricity generating station, that the Council should accept Messrs Field and Co.'s tender to perform the work for the sum of £12,086 was submitted. Alderman Brigden, in moving the adoption of the report, said the matter was before the Council at the last meeting, when another tender was recommended, but the report was then withdrawn in consequence of a communication from the Lighting Committee. It was found that after deducting certain work done by the Council, Messrs. Field's tender was the lowest by £39. The mistake occurred through a wish to expedite matters. The motion was carried.

PROVISIONAL PATENTS, 1895.

MAY 6.

8966. **Improvements in meters for measuring currents of electricity, part of the invention being applicable to electric motors for driving astronomical clocks and other like apparatus.** Henry Augustus Rowland, 55, Chancery-lane, London.

8972. **Improvements in electric railways.** William Lawrence, 29, Broadway, New York.

8994. **Improvements in and connected with arc lamps.** William Jandus, 18, Southampton-buildings, Chancery-lane, London.

MAY 7.

9010. **Improvements in electric railways.** George Edward Baird, 5, John Dalton-street, Manchester. (Complete specification.)

9050. **An improved process for the production of lead compounds or other metallic compounds by electrical means.** Ernest Bailey, Tom Cupper, Arthur Lancaster Stobbs, William Alfred Wilson, and James William Pollard, Billiter-buildings, London

9056. **Safety appliance for electrical circuits.** Siemens Bros. and Co., Limited, 28, Southampton buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.) (Complete specification.)

MAY 8.

9111. **Improvements in telephonic receivers.** Cornelis Dirk Janszen, 55, Chancery-lane, London. (Arsène Gerbert, France.)

9112. **Improvements in the method of and means or apparatus for effecting multiple telephonic communications.** Cornelis Dirk Janszen, 55, Chancery-lane, London. (Arsène Gerbert, France.)

9132. **Improvements in electrical ceiling and wall connectors.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford, Manchester. (Complete specification.)

9144. **Electrical soldering apparatus.** Gustav Binswanger and Francis William Ball, 71, Queen Victoria-street, London.

9146. **Improvements in and connected with arc lamps.** Hermann Niewerth and Regina Niewerth, 1, Quality-court, Chancery-lane, London.

9158. **An electric light bath.** George Frederick Redfern, 4, South-street, Finsbury, London. (W. Gebhardt, Germany.)

9167. **Improvements relating to telegraphic working through cable lines.** Joseph Arthur Lovel Dearlove, 24, Southampton-buildings, Chancery-lane, London.

9176. **Improvements in armatures for dynamo-electric machines.** Williams Brooks Sayers, Henry Alexander Mavor, William Arthur Coulson, and Samuel Mavor, 46, Lincoln's-inn-fields, London.

MAY 9.

9180. **A hand hoist for raising and lowering arc lamps.** George Wilson Lunn, 21, Yorkshire-street, Oldham.

9184. **An improved electric motor called the "leader" electric motor.** Joseph Waddington, Edgar Waddington, and John Waddington, Fletcher-street, Bury.

9202. **Improvements in holders for incandescent electric lamps.** Jan Meines Huisman and Henry Charles Gover, 62, St. Vincent-street, Glasgow.

9206. **An improvement in glow lamps.** Henry William Handcock and Alfred Herbert Dykes, 5, Victoria-street, Westminster.

9217. **Improvements in electrical cut-outs or safety fuses, switches, and the like.** John Benjamin Verity, Plume Works, Aston, Birmingham. (Complete specification.)

9237. **Improvements in or connected with electric conductors for telephonic or other analogous purposes.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

MAY 10.

9257. **Improvements in cells and diaphragms for use in electrolysis.** James Hargreaves, Farnworth-in-Widnes.

9262. **Improvements in incandescent electric lamps.** Arthur Bryce Mees and James Davis Pitt, Comberton Villa, Brettle Lane, Staffs.

9273. **Improvements in tubular electromagnets.** James Taylor, Heathercliff, Helsby, near Warrington.

9286. **Improvements in automatic electric switches and in their use for distribution of electricity, parts of which improvements are applicable to other automatic devices.** John Hopkinson, 5, Victoria-street, Westminster.

9312. **Improvements in electric conductors or cables.** Henry Edmunds, 47, Lincoln's inn-fields London.

9314. **Improvements in electric receivers or mechanism for actuating counting dials or the hands thereof.** Henry Lepaute, 323, High Holborn, London.

9323. **Heating, drying, and smoothing by electricity.** Leslie Bradley Miller, 2, Gray's-inn-road, London.

MAY 11.

9354. **Improvements in electric cooking and heating apparatus.** Guillaume Arnaud Nussbaum, 29, Ludgate-hill, London.

9372. **An electric oven.** Victor George Middleton and Douglas Neale, Broadway-chambers, Westminster.

9380. **Improvements in electrical-firing pistols for gun mountings.** Edward William Lloyd, of the firm of Sir W. G. Armstrong, Mitchell, and Co., Limited, and Ralph Thew Brankston, 24, Southampton-buildings, Chancery-lane, London.

9388. **Improvements in regulating appliances for arc lamps.** Rookes Evelyn Bell Crompton, 55, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1894.

7950. **Electrolytical apparatus.** Guthrie.

8328. **Electric condensers.** Threlfall. (Threlfall.)

8731. **Electric batteries.** Froggatt.

10101. **Gripping tool for electric light, etc., fittings.** Binswanger and Gibson.

11225. **Arc lamps.** Bevis and Hirst.

12973. **Casting electric accumulator plates.** Hampel.

1895.

2916. **Electric distribution.** Devonshire. (Steinmetz.)

2917. **Electrical distribution.** Devonshire. (Steinmetz.)

5196. **Thermo-electric generators.** Cox.

5693. **Electric railways and tramways.** Berg and Tarbox.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅛-5⅜
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅞-2⅝
—— Nom. Cum , 6 per cent. Pref.	2	2⅛-2¼
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	15½-15⅞
—— 5 per cent. Debenture Stock	100	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	131-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	—
Electric Construction, Limited	2	⅞-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1⅛-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	⅝-1⅛
Elmore's French Company	2	—
Elmore's Wire Company	2	1⅜-1⅝
Fowler-Waring Cables	5	⅝-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	9½-10½
—— Preference	—	12
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	21⅛-22½
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge	5	7-7⅛
—— 6 per cent. Pref.	5	7-7⅛
Liverpool Electric Supply, Ordinary	5	7 11/16-7 13/16
—— Pref.	—	—
Liverpool Overhead Railway	10	8¾-9
—— Pref.	10	14-14½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	¼-½
Metropolitan Electric Supply	10	10½-10⅝
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5½-5¾
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅝-6⅛
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7½-8
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7⅛
—— £4½ shares	4½	5⅞-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8⅛-8⅜
—— 7 per cent. Pref.	5	8⅞-9⅛
Swan United	—	—
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7⅞-8⅛
Yorkshire House-to-House	5	5⅛-5⅜

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NOTES.

Society of Arts.—The society's conversazione will be held at South Kensington Museum on Wednesday evening, June 19.

Lecture.—A paper on "Electric Lighting" has been read before the Beckenham District Council Electoral Association by Mr. F. A. Glover, of Queen Victoria-street.

Rouen Electric Tramways.—The work of laying the rails of the new electric tramways at Rouen is almost completed, progress having been made at the rate of 650ft. a day.

The Uses of Accumulators.—The adjourned discussion on Mr. J. C. Howell's paper on this subject will take place on Monday next at a meeting of the Northern Society of Electrical Engineers.

Electricity at the Berlin Exhibition.—A syndicate of firms belonging to the Society of German Electricians has been formed with the object of supplying electricity for light and power purposes to the Berlin Industrial Exhibition, which is to be opened next year.

Society of German Electricians.—The Verband Deutscher Elektrotechniker will hold its third annual meeting at Munich from July 4 to 7. The Ohm monument will be unveiled on Saturday, July 6. On Sunday an excursion will be made to the Starnberger See.

Degrees in Science in Engineering.—The University Commissioners have issued an ordinance ordaining that two degrees in science in engineering may be conferred by the University of St. Andrews—viz, Bachelor of Science in Engineering, and Doctor of Science in Engineering.

Constant Dielectric.—Prof. A. Volta has an article in *L'Elettricità* (May 12) "On the Constant Dielectric of Some Substances and Particularly of Glass," which is based upon experiments made by Prof. D. Mazzotio, particulars of which have appeared in the *Rendiconti* of the Accademia dei Lincei.

The Utilisation of Old Insulators.—Has it been reserved for the Bureau Central des Postes, Télégraphes, et Téléphones of Brussels to find out a profitable method of disposing of old insulators? In announcing a sale by auction of these articles, this official body remarks that they "will be sold *en masse* or in lots, and they can advantageously be utilised as borders for gardens"!

Electricity in Milan.—Some interesting particulars are given in a recent number of our Italian contemporary, *L'Elettricità*, concerning the development of the use of electricity in Milan. From there we gather that the number of incandescent lamps in that city rose from 3,300 in 1884 to 38,300 last year, and the number of arc lamps from 26 in 1884 to 629 in 1893, but only 624 in 1894.

Rather Premature.—A correspondent of *L'Etincelle Electrique* writes to the editor of that journal, somewhat prematurely, many may think, in view of the not infrequent revolutions of the political wheel, suggesting that the Tsar, while sitting at his palace in St. Petersburg, might open the Paris Exhibition of 1900 by pressing a button and deliver an inaugurative speech to his delighted French auditors by telephone.

Military Telegraphists.—The Telegraph Battalion of the Royal Engineers from Aldershot are to undergo their annual encampment in Woolverstone Park, Ipswich. An advance guard of 20 men arrived on Monday afternoon, and marched to the park to prepare the camp for the main body (numbering about 150), which will arrive on Saturday. The mounted men of the battalion, to the number of 70, will arrive by road on the same day.

Pride.—As our readers are aware, tenders are being advertised in this country for the electric lighting of Rangoon. This fact rouses the ire of *Indian Engineering*, which indignantly says: "Surely, with firms of such standing as Messrs. Octavius Steel, and others, who are specialists in this line, both in Calcutta and Bombay, advertising in India would have served as well, and saved the municipal coffers, which are reported as being very low." As the Scot observed, "May be aye and may be no."

A Bold Assertion.—The *Daily Chronicle* this week, with a calm disregard of fact, asserted that American engineers seem to be all agreed that steam railways are doomed within a quarter of a century, so far as America is concerned. This shows that it is unwise to generalise from a particular instance, the item apparently having been founded on the article by Mr. Joseph Wetzler (see *Electrical Engineer*, May 10, p. 539) in which he stated as his own opinion that all railways will be eventually operated electrically.

North-East Coast Institution.—We have received part 5 of vol. xi. of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders, which contains Mr. Frank Caws's reply to the discussion on his paper on "An Account of Some Experimental Studies of Ship Acceleration;" discussion on Mr. W. C. Mountain's paper on the Design and Efficiency of Plant for the Transmission of Power by Electricity;" and a paper on "The Application of the Electric Arc to Machinery and Boiler Repairs" by Mr. Henry Foster.

Electricity in France.—The Compagnie Parisienne de l'Air Comprimé is establishing a large electric central station on the Quai Jemmapes; the Société Normande d'Electricité has ordered for the central station at Rouen (*L'Industrie Electrique* says) four Willans triple-expansion engines of 180 h.p. for driving four Alioth dynamos; and the Société de Traction Electrique (Heilmann) will also use Willans engines in the central station which it is proposed to build in the neighbourhood of Paris in connection with the projected electric railway.

Postal and Telegraph Routes.—Lord Rosebery is to receive a deputation from the Association of Chambers of Commerce on Friday next at Downing-street with reference to inter-Imperial postal and telegraph routes. The association at its Huddersfield meeting passed a resolution advocating inter-Imperial postal and telegraph routes between this country and the colonies, and between the colonies themselves respectively, without such routes passing through other countries. It is probable that the Chancellor of the Exchequer and the Postmaster-General will also be present at the interview.

Books Received.—Messrs. Longmans, Green, and Co. send us "The Telephone Systems of the Continent of Europe," by Mr. A. R. Bennett; and "Problems and Solutions in Elementary Electricity and Magnetism," by Messrs. W. Slingo and A. Brooker. The latter forms one of Longmans' elementary science manuals, and embraces the South Kensington papers for the years 1885-1894. We have also received the second edition of Mr. W. Perren Maycock's "A First Book of Electricity and Magnetism for the use of Elementary Science and Engineering Students and General Readers," published by Messrs. Whittaker and Co.

Electrical Communication with Light Stations. In reply to Admiral Field in the House of Commons on Monday, Mr. Bryce said that, in addition to the works recommended in the recent third report of the Royal Commission, there were still some works, recommended in

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the first report, which had not yet been carried out. A sum of £11,000 had been placed at the disposal of the Board of Trade for the purpose of effecting electrical communication with light-vessels, etc., during the present financial year, and the Board were at present considering on which of the works recommended that amount—which was not sufficient for all—should be expended.

Closing Bulkhead Doors.—A telegram from Washington states that since the disaster to H.M.S. "Victoria," the officers of the United States navy have devoted much attention to the question of bulkheads. Chief Engineer Melville has now prepared several mechanical devices, which may be operated either by compressed air or by electricity, by means of which all the bulkhead doors of a vessel can be automatically closed at a moment's notice. The officer on deck or the man in the conning-tower, on seeing the danger, can, by simply pulling a lever, close every door instantaneously, after first having, by pre arranged whistle or bell, signalled warning to those below to hasten on deck or otherwise escape.

A New Malady.—A new malady has appeared in the telephone exchanges in America. The fatigue of listening continually at the receiver produces a humming in the ears, headache, and, finally, abscess of the tympanum. It is necessary to give an hour's rest every three or four hours to the employés. This trouble is most observable in California, and it is not known in the Eastern States, and may be due either to defective apparatus or to overwork. In examination before the Select Committee on Telephones, Mr. W. H. Preece called attention to the use of a small electric lamp which had been invented, and which, working in the call-wires, indicated "finished" or "through," and so obviated the voice calls which are sometimes so irritating.

Congress of Chambers of Commerce.—Invitations to a third congress of chambers of commerce of the Empire, which the London Chamber has decided to organise for June, 1896, have been sent by the London Chamber to chambers of commerce and other cognate bodies throughout the colonies. The first congress was held in 1886 at the time of the Colonial and Indian Exhibition, and the second in 1892, both being successfully carried through under the auspices of the London Chamber. The council of the London Chamber direct attention to the questions which might be usefully discussed by the congress, and which include light railways, and cable communication, construction, rates, codes.

Aluminium v. Picturesqueness.—The old struggle between utilitarianism, on the one hand, and beauty and historical associations, on the other, is ever being renewed. At the first meeting of the National Trust for Places of Historic Interest, etc., lately held, the Duke of Westminster presiding, reference was made to the Fall of Foyers. The British Aluminium Company proposes to dam, it appears, the three lakes in Stratherrick, above the fall, and submerge 300 acres of land, and it is contended that if this purpose be effected the cascade would become a thing of the past. The meeting expressed the hope that public feeling would be so aroused as to prevent this being done, and pronounced that the destruction of the fall would be a national loss.

Electricity Extraordinary.—The American newspaper Press is circulating a wonderful tale concerning a Chicago hotel which, it is gravely stated, is "heavily charged with electricity." The story runs that when one guest started to shave himself a huge spark leaped from the razor and startled him to such an extent that involuntary suicide nearly resulted. We are further informed that another guest stepped into a bath-tub and immediately howled lustily for assistance, being assailed with a sensation of having thousands of needles unceremoniously jabbed into his person. The employés of the hotel broke open the door and rescued the victim, who, however, is said to have experienced no bad effects from his marvellous bath. The tale concludes with the statement that the hotel is losing patronage, and will probably be pulled down!

Obligations of Electric Light Companies.—In answer to Mr. Weir in the House of Commons on Tuesday, Mr. Bryce said, "My honourable friend is not correctly informed as to the state of the law. Private electric lighting companies having statutory powers are under obligations similar to those imposed on local authorities, and are also prohibited from using overhead wires without the consent of the Board of Trade and the local authority. Private electric lighting companies not having statutory powers are subject to regulations for the protection of the public safety prescribed under the provisions of the Electric Lighting Acts, 1882 and 1888, although the use of overhead conductors is not prohibited by those Acts. Moreover, urban authorities under the Public Health Act of 1890 are empowered to make regulations for the prevention of danger or obstruction to the public from wires stretched over, along, or across any street."

Liverpool Engineering Society.—The following visits will be made to works during the forthcoming summer: Saturday, June 8, to the Liverpool Corporation reservoirs and filter-beds at Rivington—Mr. Jos. Parry, M.I.C.E., water engineer; Friday, June 21, and Saturday, June 22, to the main sewerage works, pumping station, and refuse destructor of the borough of Cambridge—Mr. J. T. Wood, M.I.C.E., chief engineer; Saturday, July 6, to the Snowdon Mountain Rack Railway in North Wales—SirDouglas Fox, M.I.C.E., chief engineer, and Messrs. Holme and King, contractors; Saturday, August 3, to the site of the Elan water supply of the Birmingham Corporation at Rhayader, Radnorshire—Mr. Jas. Mansergh, M.I.C.E., chief engineer; Friday, September 6, to the Sunlight Soap Works, Bebington—Messrs. Lever Bros., Limited, proprietors; and on Saturday, September 21, to the Wirral Railway Works—Sir Douglas Fox, M.I.C.E., chief engineer.

City Commission of Sewers and Telephony.—On Tuesday a meeting of the City Commission of Sewers was held at the Guildhall, Mr. H. T. Gordon presiding. Mr. H. Montague Bates, the clerk, reported that in order to ascertain the experience generally of telephone users in the City as to the efficiency and cost of the existing telephone service, he issued circulars to all the subscribers to the National Telephone Company as to whether the provision now made for the telephone service was adequate and whether it was expedient to supplement or improve the provisions, either by the granting of licenses to local authorities or otherwise. He had received 1,085 replies, from which it was quite clear that the existing telephone service was costly and inefficient. The Court referred the report to Mr. A. C. Morton, M.P., Mr. Bates, and the Remembrancer, to decide as to the best way of placing the facts contained in it before the Select Committee of the House of Commons now considering the matter.

Steam-Engines Bill.—The Select Committee to which the Steam-Engines (Persons in Charge) Bill, introduced by Mr. W. Allan, was referred, resolved, says the *Times*, after a somewhat heated discussion on Wednesday, not to proceed with the consideration of the measure, the fate of which is accordingly sealed for the present session. It appears that, in order to facilitate the passing of the Bill, Mr. Allan

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agreed to adopt a suggestion from the Treasury bench excluding marine and other engines from its scope, and, pursuant to this arrangement, the committee were asked to take evidence only in relation to the clauses which would remain after the proposed alteration was made. A motion to this effect was carried by the casting vote of the chairman (Sir E. Hill), whereupon, Mr. Havelock Wilson and others having protested against the elimination from the Bill of provisions to which they attached especial value, it was decided, on the motion of Mr. Brunner, to take no evidence at all, but simply to send the measure back to the House.

Personal.—Mr. John Darney has been compelled to resign his position as honorary secretary to the Northern Society of Electrical Engineers owing to his removal from Manchester. His place has been taken by Mr. J. Vincent Swindells. Mr. Stanley Franklin, who has superintended the fixing of electrical machinery at Cheltenham for Messrs. Siemens Bros., was on Thursday last the recipient of a pleasing token of the appreciation felt by the chairman of the Electric Lighting Committee of the way he has carried out his work. Alderman Norman, at the conclusion of the dinner given in honour of the completion of the station, presented Mr. Franklin with a handsome walking-stick, and at the same time assured him that his efforts to give the Corporation satisfaction had not passed unnoticed. This present is a new departure, and we are pleased to see that at Cheltenham the chairman of the Electric Lighting Committee has recognised the value of the services of engineers placed over the work by the contractor. We understand that during the month in which Mr. Franklin had to run the plant no hitch occurred in the lighting.

The Electric Lighting of Railway Carriages.—A paper with this title was read at a recent meeting of the Hanover Elektrotechniker Verein by Dr. Büttner, of Hagen-i.-W., who, after touching upon the gradual development of the various systems in use, which may be divided into two groups—the lighting of the whole train from one or two carriages, and the independent lighting of each carriage by accumulators—described the electric lighting of the trains on the Danish State Railways in Seeland, of those on the Novara-Seregno line in Italy, the Jura-Simplon railway, and on the Dortmund-Gronau line, and of the Imperial German railway postal vans. He then drew comparisons between gas and electrical lighting unfavourable to the older illuminant. The disastrous effects of a railway collision had frequently, he remarked, been heightened by the gas setting fire to the carriages. The weight of the electric lighting apparatus, too, was much less than that of the gas apparatus of equal efficiency. The cost of electricity, moreover, compared favourably with that of gas. A gas plant for 170 carriages cost £2,500; an electric charging station of the same capacity £1,250. Dr. Büttner regretted, in conclusion, that 85 per cent. of German railway carriages are still lighted by gas.

Educating the Public.—Mr. S. V. Clirehugh, A.M.I.C.E., the consulting electrical engineer to the Corporation of Eccles, has delivered a lecture there in the Town Hall on "Electricity for Lighting, Heating, and Motive Power." Mr. Alderman Kendall, J.P., chairman of the Electric Lighting Committee, occupied the chair. The lecturer commenced by saying that he had to deal with the commercial side of the question, and that was what they had for the greater part come to listen to. If he were asked what electricity was he must candidly confess he did not know, but as to the generation and control of electricity these had come within the province of science. He enlarged upon the application of electricity as a motive power, and said that there was a great future in that direction. Coming to the question of cost, the established expense of the introduction was £1 a light, with all the necessary wires, and there was a company that would carry out the wiring on the hire-purchase system, so that a man who would say that he could not afford £10 or £20 to supply his shop, could do so by instalments. The lecturer proceeded to lay before the meeting his estimate of the cost of installation, etc., and deduced from the figures before them a saving to the consumer.

Telegraph Offices.—In the House of Commons, in answer to Mr. Henniker Heaton, Sir J. Hibbert said: "I cannot hold out any hope of an abolition of the guarantee system, but I would remind my hon. friend that much has been done of late years to encourage the extension of telegraphs in country districts. Rural sanitary authorities have been empowered to give guarantees for this purpose; the conditions of the guarantees have been very considerably lightened; and the Post Office is constantly making enquiries as to whether the business likely to be done at village post offices will justify the extension of the telegraph without any guarantee at all. The result has been that the number of country telegraph offices is increasing steadily and at a growing rate. In 1890-91 the increase was 275; in 1893-94 it was 673." Mr. A. Morley, also in reply to Mr. Heaton, said that there were about 500 telegraph offices in the metropolitan district, or, in other words, about one office to 10,000 people. Elsewhere there were about 9,150 offices, or one office to 3,600 people. The offices in the Metropolis had been established to meet the requirements of the public, and were only maintained if they paid their way To close any of them would not facilitate the establishment of telegraph offices in rural districts.

Electric Lighting in London.—On Monday Mr. Hazell, in the House of Commons, asked whether the Board of Trade had declined to grant orders in the Metropolis unless the power of purchase by the local authority was reserved at the end of 42 years from August 22, 1889, under the terms of sub-section 2 of the Act of 1888, and whether, as the period of 42 years was now reduced by nearly seven years and was daily diminishing, the President would consider the desirability of giving companies more favourable terms. Mr. Bryce said that was so; but Section 2 of the Electric Lighting Act, 1888, provided that the local authority might purchase the undertaking after the expiration of a period of 42 years or such shorter period as was specified in the provisional order. The Board of Trade had held that it was in the interest of London that the power of purchase by the local authority or authorities should as far as possible operate at the same date over the whole of the Metropolis. To this policy the Board of Trade adhered. The time did not seem to have arrived when it became necessary to consider whether any relaxations in the terms on which such undertakings may be purchased might require to be made in order to render it worth the while of companies to enter upon new enterprises.

English Companies in Spain.—Our Spanish contemporary *El Telegrafista Español y Revista General de Electricidad*—to give it its full title—has an article in a recent issue severely denouncing English telegraph and other companies whose sphere of operations lies wholly or partially in Spain or her dependencies. In one portion of the diatribe we are told that "English industrial companies continue to treat Spain as a conquered country." In another that "undoubtedly English companies consider us, from a telegraphic point of view, to be on the level of the African peoples, and

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they consequently treat our country as a colony which they must exploit for their exclusive profit." And again, "the English, so careful in their own country to observe the law, seem to do their utmost to evade it when they establish themselves amongst us." These rambling observations are, it appears, induced mainly by alleged grievances against the Cuba Submarine Company and the Spanish Company upon questions of privilege, but there is a special grumble against one company that although, according to the terms of its contract, it was to substitute its English staff by Spanish employés in proportion as the latter became sufficiently competent, not a single Spaniard, the article affirms, has yet been found with the necessary aptitude. "Who," queries our contemporary somewhat bitterly, but we hope not altogether seriously, "who can drag an Englishman from a position where a penny is to be gained?"

Antiquity of the Incandescent Lamp.—One of the most interesting sights of New York is a performance at one of the Jewish theatres on the Bowery, there being several near Canal-street patronised exclusively by Russian Hebrews, in which the plays are produced in the Jewish-German-Russian jargon with a mediæval crudity. Each theatre has its own playwright, who, however, owing to the fondness of the audience for realistic scenes, has to divide the honours of the reproduction with the important personage who creates the realistic accessories. How important the functions of the latter are, says the *Electrical World*, will be evident from the following description of a scene from a play entitled "Jonah," produced at the Old Bowery Theatre. "After Jonah has been thrown overboard, for a moment," says the reporter, "it appears that nothing can save him. But just as he is sinking for the last time a great fish comes along, shaped something like a flounder, and deporting itself like a ball of rubber; it opens a very wide mouth and Jonah climbs in. Instantly the ship, which has been hammering the stage boards in its wild tossing, becomes still. The ballet sailors on the deck set up a jubilant chorus, and a gauze-dressed angel drops down from the flies, while the fish—which has disappeared behind the scenes—turns about and re-enters with a new side presented to the audience. This new side is as open as the day. Through an oval window in the whale's larboard quarter Jonah is disclosed sitting in great splendour of red and green, with glow lamps, and not a suggestion of discomfort." The anachronism of the incandescent lamp probably did not appeal to the enthusiastic audience.

London Chamber of Commerce.—The thirteenth annual general meeting of the London Chamber of Commerce was held on Tuesday afternoon in the council-room, Botolph House, Eastcheap—Sir Albert K. Rollit, president, in the chair. The report showed that the work of 1894 had produced more important results than that of any previous year. The financial record was satisfactory, a balance of £534 having been carried forward, while there had been an increase of 360 members during the year, and the number of meetings had risen from 280 in 1893 to 334 during the past 12 months. The report and accounts having been duly adopted, on the motion of the chairman, seconded by Mr. W. H. Willans, the following gentlemen were added to the council: Colonel G. R. Birt, Mr. T. F. Blackwell, Sir E. H. Carbutt, Mr. J. Colman, jun., Mr. E. J. Gillespie, Mr. G. N. Hooper, Mr. J. J. Jackson, Mr. G. S. Mackenzie, Sir Samuel Montague, M.P., Mr B. S. Odling, Mr. R. H. Pringle, and Mr. A. Serena, being proposed by Sir G. Baden-Powell, M.P., and seconded by Mr. McAllister. Sir Albert Rollit was unanimously re-elected president, and Mr. J. Chambers and Mr. S. B. Boulton vice-presidents for the ensuing year. Lord Brassey, Sir G. Baden-Powell, M.P., Sir Douglas Fox, Major-General Sir F. R. Pollock, and Sir F. Dixon-Hartland, M.P., were elected members of the council of reference. Sir A. Rollit delivered an exhaustive address on the progress of British trade, and argued that his conclusion was that after a long period of depression, which had been wonderfully well borne by the great majority of the working classes, there were indications of an improvement, if we would learn lessons, partly from our foreign competitors.

Curious Procedure.—The *Times* says: "We have received from a correspondent, who states that he is not a shareholder or in any way interested in the National Telephone Company, but is simply a customer of it, a copy of a printed circular addressed to him by Mr. de la Hooke, the clerk of the London County Council. It cannot be considered a dignified course for a public body like the Council, who are trying to buy the telephones of London, to send round to all telephone users, with a view of depreciating the property, such a circular (stamped for reply) touting for complaints. The circular states that a select committee on telephone service has been appointed "to consider and report whether the provision now made for the telephone service in' London and other 'areas is adequate, and whether it is expedient to supplement or improve this provision either by the granting of licenses to local authorities or otherwise.' The Highways Committee of the London County Council, to whom the duty of procuring evidence on this matter is referred, being of opinion that telephone service in the Metropolis should be rendered cheaper and more efficient, have submitted their views to this effect to the Select Committee, and similar evidence has been tendered by the Commissioners of Sewers of the City of London. The committee of the Council are anxious to know accurately what is the opinion of the users of telephones in London as regards efficiency, and answers are requested to the following questions—'(*a*) Is the existing telephone service of the National Telephone Company efficient and satisfactory to you? (*b*) If it is not satisfactory, in what respects is it unsatisfactory? (*c*) What suggestions (if any) would you make for the improvement of the service?'" It will be noticed that the Commissioners of Sewers have adopted a similar course.

Products of Combustion of the Electric Arc.—This is the title of an article by M. N. Gréhant in *Comptes Rendus*, p. 815. The author remarks that among the gases liberated from carbons kept incandescent by the electric arc is carbonic oxide. His method of operating was as follows: Around a lamp, the carbons of which gave a powerful and constant light, was arranged a small wooden box, 43cm. long, 29cm. wide, 60cm. in height, and of a capacity of 75 litres. Two metal tubes were fixed on two opposite sides, one at 2cm., the other at 32cm. from the bottom of the box, which was almost completely closed by a lid traversed by the cylindrical body of the electric lamp. Three experiments were made. They consisted in causing a dog to breathe for half an hour the gases resulting from the combustion of the carbons combined with the exterior air drawn in by the respiratory movements through hydraulic valves. The inspiration took place in the box, the expiration outside. The arterial blood of the dog, taken in the carotid artery, was analysed before and after each experiment. In the first, the dog was placed in the box after the lamp had been running half an hour. The analysis gave $\frac{1}{1400}$ as the proportion of carbonic oxide contained in the air breathed by the animal. In the second, the dog was put in the box at the moment of lighting the arc. The proportion of carbonic oxide was then $\frac{1}{3000}$, the reduced

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quantity being due to the gas not having been able to accumulate in the box. The treatment of carbonic anhydride by barytes water contained in a tube placed between the electric arc and the exhaust-valve gave $\frac{1}{87}$ for the proportion of this gas, or 53 times greater than that of the oxide of carbon. The third experiment, made under the same conditions with another dog, gave $\frac{1}{2500}$ as the proportion of carbonic oxide, and $\frac{1}{62}$ as that of carbonic anhydride. M. Gréhant thus concludes his article: "It is, therefore, certain that the carbons of the electric arc throw off carbonic oxide in small quantities. If the lamps are in rooms of small size, such as certain of those containing machines generating electricity, the liberation of the toxic gas in the close atmosphere may contribute to produce among the workers the serious maladies which have from time to time been reported. A thorough system of ventilation should consequently be established, which would carry away all the products of combustion."

Electric Lighting of Cars.—The lighting of the cars of a cable road by electricity is a novelty, and requires the use of some special apparatus. In the main, the plan adopted on the Brooklyn Bridge, New York, says the *Scientific American*, resembles the now familiar trolley system. A bare copper wire is suspended from poles and from the framework of the bridge. This wire is carefully insulated, the return is made through the rails in the usual way. The current is supplied from the power-house in Brooklyn. It is led to the centre of the bridge through a feeding cable, which there divides into two branches, one leading to each of the towers and there connecting with the overhead wire. The overhead wires are in turn connected together at intervals of 500ft. The height of the wire above the car was regulated by the framework, which extends over the three suspension spans. The distance that this framework clears the car only allowed the wire to be suspended 9in. above the roof of the car. At first it was thought that a regular trolley with a short pole could be used, but the rocking and swaying of the cars was so great in proportion to the distance of the car from the wire that it had to be abandoned. Springs were used to allow the trolley a certain amount of play, but this was not enough to keep the wheel on the wire. A roller was then substituted for the wheel. This roller is made 18in. long, and is mounted in two arms, with which the roller forms a triangle, the apex being attached to the hinge and spring. The length of the roller is really greater than is necessary, but it allows a safe margin, and there is very little chance of it ever jumping the wire. In the daytime the roller is lowered to avoid unnecessary friction. When the lamps are to be lighted, the trainman of each car pulls a lever at one end of the car which operates bell cranks and a connecting-rod, which raises the roller into contact with the wire. It has been found advantageous to have the roller trail, no matter in which direction the car may be going. On the Brooklyn Bridge the lighting trolley or roller is tripped and reversed automatically in the stations while the cars are being switched, by means of a rigid frame. The cars are all connected by wires, so that if the trolleys on all the cars but one should get out of order, that one would be sufficient to light the train. When the cars are being switched this system prevents the flickering of the lights. As in the bridge itself, there is a slip or expansion joint in three places to allow for the expansion and contraction caused by changes of temperature. Great care is taken to maintain an even tension on the line.

Telephones and Thunderstorms. — Our contemporary the *Lancet* having fortunately no gas-*cum*-electricity explosions, nor reports thereon, to comment upon, has now struck out in a new line under the heading of telephones and thunderstorms. It says: "It is to be remembered that an overhead telephone wire becomes in point of fact a lightning conductor, and in this capacity may act in two ways: (1) by equalising differences of potential it may prevent the occurrence of the disruptive charge; or (2) receiving a lightning charge it may carry the current to earth. With reference to the first point, there can be little doubt that overhead conductors if connected to earth do play an important part in the distribution of atmospheric electricity. Lord Kelvin in a recent paper (read before the Philosophical Society of Glasgow) states that the difference of potential he obtained between the earth and an insulated burning match placed 9ft. above the ground was 200 to 4,000 volts. What, then, is the result of permanently connecting by a good conductor the earth and the atmosphere directly above it, a condition which exists in the case of single-wire telephone circuits? Such an arrangement must tend to equalise potential and prevent the accumulation of those charged masses which no doubt form the nucleus of the storm cloud. This equalisation will continue to take place in all conditions of weather. But when a storm does occur it is obvious that if struck by lightning the wire carries the current to the point of greatest danger—viz., to the instrument and to anyone in its vicinity. Therefore, unless the strictest structural precautions be taken, such a wire becomes a source of danger rather than of safety. To obviate this danger, every post or support for overhead wires ought to be fitted with a lightning guard, and every instrument, whether using the earth as a return or not, should be fitted with an efficient form of lightning arrester. Where the overhead wires are not connected to earth, as is the case with overhead lighting mains and twin telephone circuits, any equalising effect upon potential difference is practically lost, and any circuit connected with overhead wires must be dangerous, inasmuch as such wires become lightning conductors in all but the saving device of an earth connection. For lighting mains it can scarcely be doubted that the underground system is in most respects the better: (1) for obvious reasons connected with the size of the cables; (2) for the electrical reason that if carried overhead no earth connection is allowable, by the rules of the Board of Trade. For telephones the adoption of the twin-wire system seems to bring with it the advisability of placing the wires below the surface of the ground, inasmuch as this system does away with the earth return as part of the circuit. It therefore appears that from an electrical point of view there may be in overhead wires an element both of safety and of danger. The latter will certainly predominate unless supports be protected with lightning guards and every instrument provided with an efficient protector—that is, with an unfailing means of carrying a strong current to earth without passing through the instrument. Is this secured in practice? Can it be secured with any certainty by even the best lightning arrester or earthing device of any descripton? So long as the coarse expedient of a connecting wire is necessary for the guidance of electrical energy, so long must this question of wiring, with its safeties and its dangers, be one of great and growing interest. But it may be pointed out that if every house were fitted with an efficient form of lightning guard a greater immunity from lightning discharges would be secured than that which at present exists with the closest network of overhead telephone wires." This subject is even more remote from what one would expect in a medical paper than were the previous articles on explosions.

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ELECTRIC LIGHTING OF TRAINS.—II.

BY R. W. WEEKES, WHIT.SCH., A.M I.C.E

(Continued from page 445.)

There have been many engineers at work in England on the subject of the electric lighting of trains, and a brief historical *résumé* will be of interest before commencing to describe those systems which have survived the test of everyday work. Some of those systems which have dropped out of the running have been hardly dealt with, as extraneous reasons—such as insufficient power in the locomotive boiler, etc.—have led to their being discontinued. Also, there has always been the disadvantage felt by young competitors trying to establish a business on ground already occupied. In the present case there has been felt a want of interchangeability between portions of the electrically-lighted trains and other carriages otherwise lighted.

There have been several papers read on this subject before different engineering institutions which are now historical, and which are well worth reading by anyone interested. The first of these was read by Mr. W. H. Massey before the Society of Telegraph Engineers and Electricians in March, 1884, and was called "Notes on a Train-lighting Experiment." The discussion following on this paper is most interesting reading, many of the speakers being still the leaders in all discussions at the now "Institution of Electrical Engineers." The next paper of interest is one by the late Mr. W. Stroudley, M.I.C.E., read before the Institution of Civil Engineers in 1886. Then in May, 1891, Mr. W. Langdon read a paper before the same institution on "Railway Train Lighting."

The first recorded attempt made in England to light a part of a train electrically was in October, 1881, when the London, Brighton, and South Coast Railway fitted a Pullman car with accumulators. The car thus lighted was employed in regular traffic between Brighton and London. The cells were charged during the night at Victoria. In 1881, Mr. Alexander Siemens lighted up a train on the North of Scotland Railway, using a Brotherhood engine coupled to a D 3 Siemens dynamo placed on the engine. Some 30 Swan lamps were placed in the train, but the directors of the railway would not proceed with the scheme on account of cost. In 1883-4, a novel experiment was tried by Mr. W. H. Preece on the London and South-Western Railway. Mr. Preece's idea was to employ the movement of the train to compress air into a chamber, and to use the air so compressed to drive a dynamo by means of a compressed-air engine. The air was compressed to 500lb. per square inch by means of an air-pump driven from the axle of the guard's van. Although to a large extent successful, the experiment was finally abandoned. About this date the late Mr. W. Stroudley commenced to investigate the subject in conjunction with Mr. E. J. Houghton. In December, 1893, the first train lighted by them commenced running on the London, Brighton, and South Coast Railway. In the first 11 months it made 2,352 trips, covering some 27,500 miles. The number of trains was gradually increased, various improvements being made. In 1886 this company had three trains fitted with dynamos driven off the axles of guards' vans and used in conjunction with accumulators to light the trains. At the present time the number of trains so lighted has increased to 40. In August, 1884, the London and North-Western Railway applied the electric light to a short train travelling between Manchester and Liverpool. The equipment consisted of a dynamo coupled to a Brotherhood engine supplied with steam from the locomotive boiler. It was placed in an iron compartment behind the tender, and hence was under the control of the engine-driver. The lamps were connected direct on to two wires led from the dynamo throughout the length of the train, and no accumulators were used.

In November, 1884, Mr. W. H. Massey fitted up a train with electric light for the Metropolitan District Railway. This plant, which was successfully run for two months, is of great historical value. I am assured by Mr. Crompton that the first Willans central-valve single-acting engine made was employed to drive a Siemens dynamo in this attempt to induce railway engineers to take the matter up. The engine and dynamo are shown in Fig. 2. Mr. Massey found that by evaporating 211lb. of water into steam at a pressure of 120lb. per square inch, it is possible to keep 50 lamps, of 16 to 18 candles each, going for one hour. He also stated that as the efficiency of the dynamo used was rather low, on account of the reduced speed of driving, it is probable that slightly better results might be obtained in cases where the machinery is more perfectly adapted to the work. Taking matters as they were, however, 4½ h.p. was used in the lamps and leads, over 30 per cent. of the brake horse-power of the engine was wasted in the dynamo, and nearly 15 per cent. of the gross power was lost in engine friction, so that the indicated horse-power of the engine (7·175) was obtained for about 30lb. of water per indicated horse-power hour, which is a fairly economical performance. The contractors made a trial of the same engine and found the consumption of water to be only 28lb. per indicated horse-power hour, but Mr. Massey was not present at that particular trial. The complete plant in the guard's van consisted of an engine, a dynamo, a launch boiler, water-tanks, and coal-boxes, so that the cost of supply could be accurately found. Fifty-two Swan lamps of 18 c.p. (20 c.p. nominal) were used, and it was deduced that the working expenses of the electric light would be as follows if steam could be taken from the locomotive boiler:

	s.	d.
Coal, per thousand lamp hours.....	3	9
Water „ „	0	3
Oil and waste „	1	3
Lamp renewals „	2	6
In all	7	9

to which must be added interest on capital, and charges for depreciation and repairs. The first cost of fitting up a train

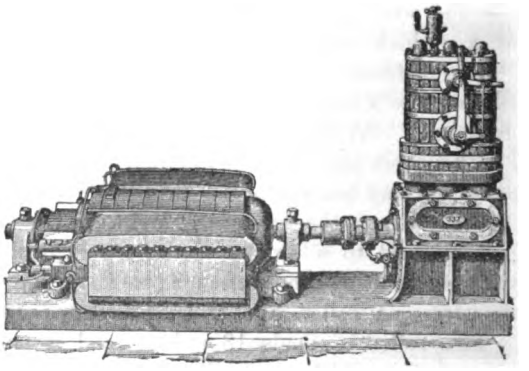

FIG. 2.—The first Willans Central-Valve Engine, as used with Siemens Dynamo for Train-Lighting in 1881.

with 50 lamps and suitable machinery, etc., would be about £170. It will be seen that no labour was charged, but assuming that this, with repairs, brought the total up to 15s., the cost per candle-power hour would only be $\frac{180}{1{,}000 \times 18}$ d. = ·01 pence.

At the end of 1885 Mr. Crompton commenced to supply some train-lighting sets to the Great Eastern Railway. A Crompton dynamo, coupled to a Tower spherical engine, was placed on the boiler just behind the steam-dome. Seven trains were eventually lighted direct in this way, but it was found that the locomotive boilers had only just sufficient steaming capabilities to supply their own engines. The Tower engines, although fairly economical at first, took a large amount of steam when the packing on the spherical surface began to wear. These causes led to the abandonment of electric lighting on that line.

In July, 1886, the Great Northern Railway Company applied the electric light to one of their metropolitan trains, and subsequently several more have been fitted, until at the present time this line has some 10 electrically-lighted trains running; these are always coupled and never broken up. In this case, also, the energy is taken from the axle of the van. In 1889, Mr. W. Langdon again took up the question of electric lighting of trains. In the early days he had

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attempted to light a train from primary batteries, but, as will be seen from the discussion on Mr. Massey's paper, the impracticability of this method was soon found out. In the new attempt, Mr. Langdon used the apparatus for obtaining constant potential from a dynamo driven from the axle of the guard's van, which will be described in following articles. The express trains in which it was used had to be broken up frequently, and hence accumulators were placed in nearly every carriage. Other recent systems will be described, including that used by the Railway Automatic Electric Light Syndicate on the underground railways in London.

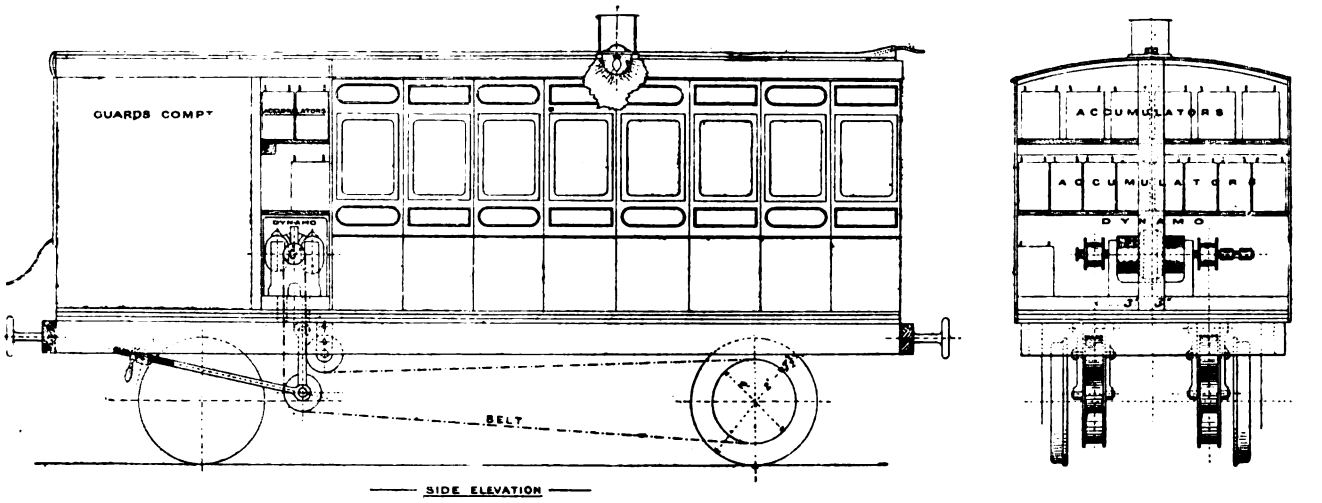

FIG. 3.—Elevation and Section of L. B. and S. C. Railway Guard's Van, showing method of Tightening Belts and arrangement of Plant.

I propose to describe the various arrangements for the lighting of trains electrically in England in order. The length of time in which each has been at work will determine the sequence.

LONDON, BRIGHTON, AND SOUTH COAST RAILWAY.

The electric lighting arrangements used on this company's lines have been designed and improved by the late Mr. W. Stroudley and Mr. E. J. Houghton. The dynamo is placed in the guard's compartment, and the accumulators are either distributed over the whole of the train—a certain number in each coach—or they are all put in the same vehicle as the dynamo. In the former case, each carriage carries its own supply of electricity; whilst in the latter, it is concentrated in the carriage containing the dynamo, and the trains so fitted are never uncoupled. For local services this is no drawback, as it is a great advantage to have the accumulators of a large type, and all in one place. Brush 5 L dynamos, capable of giving 55 amperes at 70 volts, are employed. They are furnished with a pulley at each end. Link leather belts, 4in. wide by 34ft., are led from the far axle of the carriage over jockey pulleys to the dynamo, Fig. 3. The tension of the belt is adjusted by one of the pulleys. As soon as the train moves the dynamo armature rotates. Attached to the dynamo

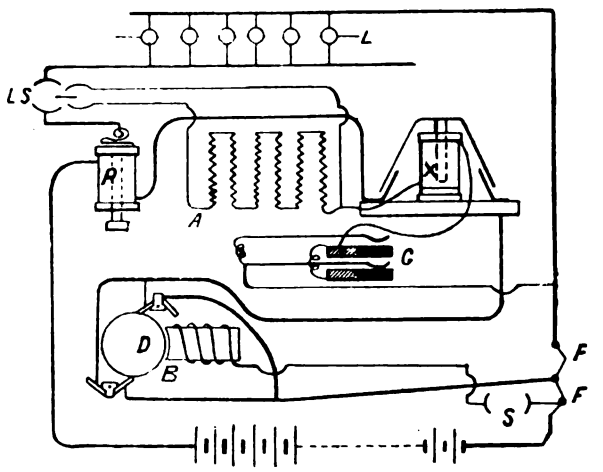

FIG. 4.—Diagram of Connection in L. B. and S. C. Railway Guard's Van.

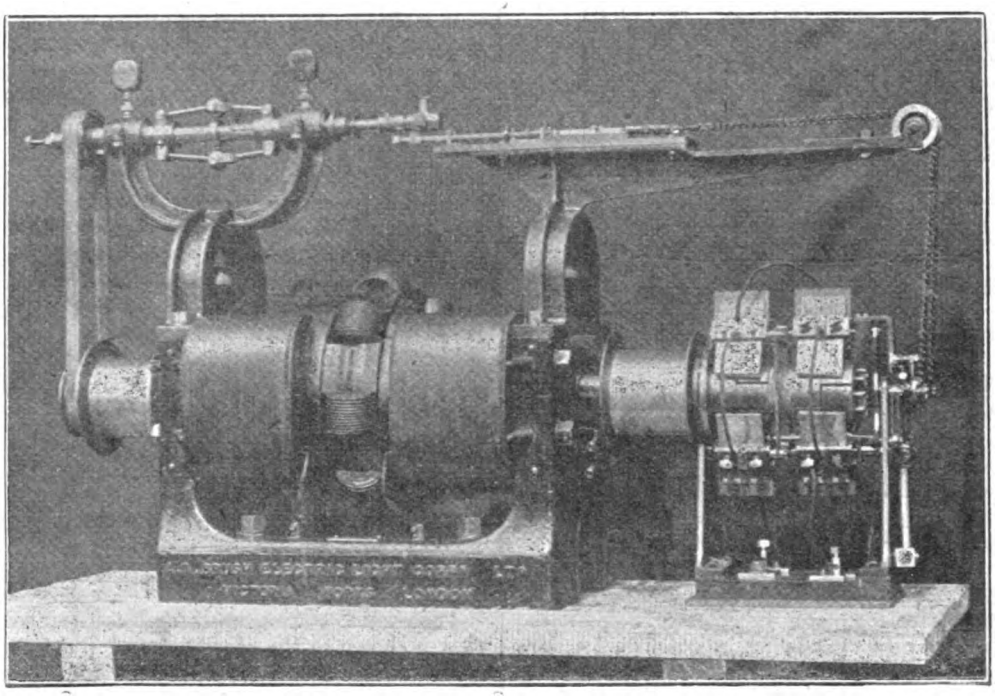

FIG. 5.—L. B. and S. C. Generating Gear, showing Governor and the Double Set of Brushes.

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by means of a small strap, is a centrifugal governor, which automatically controls the brush gear. When the train attains any prearranged speed—say, eight miles per hour—the governor closes a relay through an electromagnet, X, (Fig. 4), thereby putting the accumulators into the dynamo circuit, and causing the dynamo to charge them. As the speed of the train increases, the E.M.F. and the current of the dynamo rise—the governor gradually draws the brushes forward so as to prevent sparking at the commutator. As the speed of the train diminishes the reverse operation takes place, the brushes gradually returning towards their original position, until at the eight miles per hour the governor breaks contact, and the dynamo ceases to charge. The dynamo is fitted with double sets of brushes, as will be readily seen from Fig. 5. One set is used for each direction of rotation corresponding to the two different directions in which the train may travel.

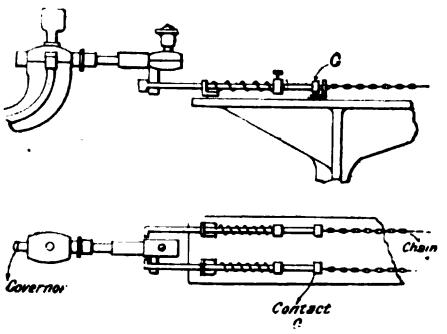

FIG. 6.—Details of Governing Gear.

The direction of rotation of the governor determines which of the sets shall be used in the manner shown in Fig. 6. One rod is used to control by means of a chain each of the sets of brushes. Each of these two rods has a similar relay contact, as shown in G, Fig. 4, and is moved to-and-fro over a considerable range by the governor, the position of the rod at any time depending only on the speed of the train. The extension of the governor spindle carries a mandrel free to rotate in it, but prevented by a wing plate, seen in Fig. 6. This mandrel is turned by friction when the train starts till the wing plate comes against either one or the other of the rods with which it engages.

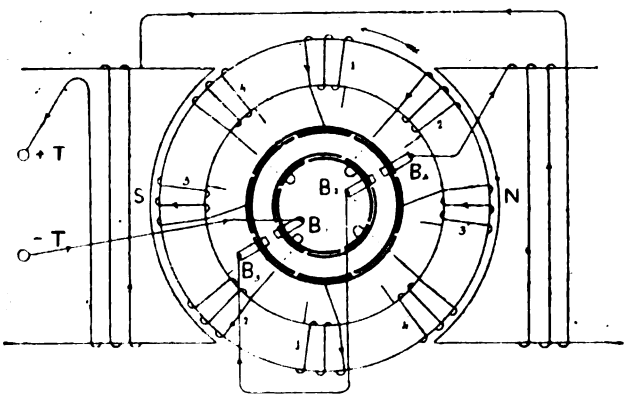

FIG. 7.—Diagram of Connection in the Brush Armature.

Any increase of speed then causes the governor balls to fly out, and the rod is drawn back by the force thus obtained, until, firstly, the brushes are put on to the commutator, and then by the relay the charging circuit is closed. Placed in the dynamo circuit there is a regulator, consisting of a solenoid with an iron core, R (Fig. 4), to which is attached some German-silver wire made in the form of a bed spring. This resistance is in the lamp circuit, and acts in such a manner that as the current in the dynamo circuit varies, more or less resistance is automatically inserted in or removed from the lamp circuit by the spring being gradually lifted up from or lowered on to the conducting plate. In this way the potential of the lamps is maintained as constant as possible. (A wire connection between A and B in Fig. 4 has been accidentally omitted.) Twenty-three of the 19 L accumulators of the Electric Power Storage Company are used in each of the uncoupled trains. The accumulator plates last about two and three-quarter years on the average, but have to be dismantled every 16 months and thoroughly cleaned. They have a capacity of some 350 ampere-hours. Lately, some of the K type have been used for renewals. Thirty-eight lamps of 16 c.p. are used per train, and they last about six months.

Through the kindness of Mr. E. J. Houghton, I was allowed to inspect this gear in work under the able guidance of Mr. W. Payne. The first point that strikes the casual observer is the fact that the E.M.F. of the dynamo rises so little with the increase of speed, although no regulator is used in the exciting circuit. This is the peculiar feature of the Brush open-coil armature, and is due to the great armature reaction found in these machines. Another way of stating concisely the same fact is to say that the self-induction of the coil is so arranged that it is impossible to obtain more than a certain current out on account of the back E.M.F. induced. Many argue that these two effects are both present, but I have found from experience on alternators that in armature cores carrying fluctuating currents the two effects are synonymous. In this case the speed of the alternator when working on the accumulators varies from 500 up to 2,000, and yet the voltage at the terminals does not vary more than about 10 volts. The only trouble found with the automatic gear is that common to almost all mechanical contrivances of the same nature. The friction of the brush rocker and the governor gear makes it difficult to regulate exactly for both ascending and descending speeds. In this way, if the governor puts the brushes on at exactly the right moment, it is liable, due to the lag caused by friction, to delay taking them off till after the speed has fallen slightly below the right value.

In some older arrangements of plant still in daily use electromagnets are used to put the brushes on at the right moment, and at the same time to connect the circuits. In this case the lead of the brushes is not varied with the speed, but it is found that the wear due to a little sparking from this cause is not excessive. In fact, the brushes last as long as those on the plant described above. The oiling arrangements have been most carefully considered. Ring lubrication is used, and any deficiency of oil due to waste is made up from an inverted bottle, the nipple of which is supported in the oil-chamber at the correct level for the oil. In this way the machinery often runs a fortnight without additional oil.

Mr. E. J. Houghton has kindly furnished the following figures as to the cost of lighting the train under his charge: The trains cost about £400 each to equip, and the working cost for maintenance and renewals for the 12 months ended December 31, 1894, was £54 per train. There are now in use 36 suburban block trains of 10 to 12 coaches each, and four main-line fast trains equipped with this system, or a total of 410 coaches, including Pullman cars. Experience has proved that these trains are more serviceable than gas-lighted trains, being always ready to run, and to run continuously. They do not need haulage to charging stations or to be left at any particular depôt. It is estimated that the company gets about 15 per cent. more work out of them than from gas-lighted trains, so that if, for the purpose of this comparison, we take the cost of building a 10-coach train at £3,000, there would be a saving of about £45,000 in the construction of 100 trains—*i.e.*, 85 electrically-lighted trains would do the work of 100 gas-lighted trains. Mr. Houghton finds that the cost of upkeep decreases considerably with the number of trains fitted.

The London, Brighton, and South Coast Railway are to be congratulated on the success of their engineers in their dogged efforts to perfect the lighting systems on their trains.

ELECTRIC LIGHTING IN THE FAR EAST.

AN ALTERNATING STATION AT HONG-KONG.

The central station at Hong-Kong (of which an interior view is shown in the accompanying illustration, Fig. 1) has now been in successful operation for 5½ years, it having been installed and the public lighting started in December, 1890. It was designed by J. W. Hart, Esq., M.I.C.E., of 39, Victoria-street, Westminster, S.W., for the Hong-Kong Electric Company, Limited, and the whole of the plant,

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including engines, boilers, dynamos, motors, switchboards, lamps (arc and incandescent), mains, columns, etc., was supplied by Messrs. Johnson and Phillips, of Charlton, Kent.

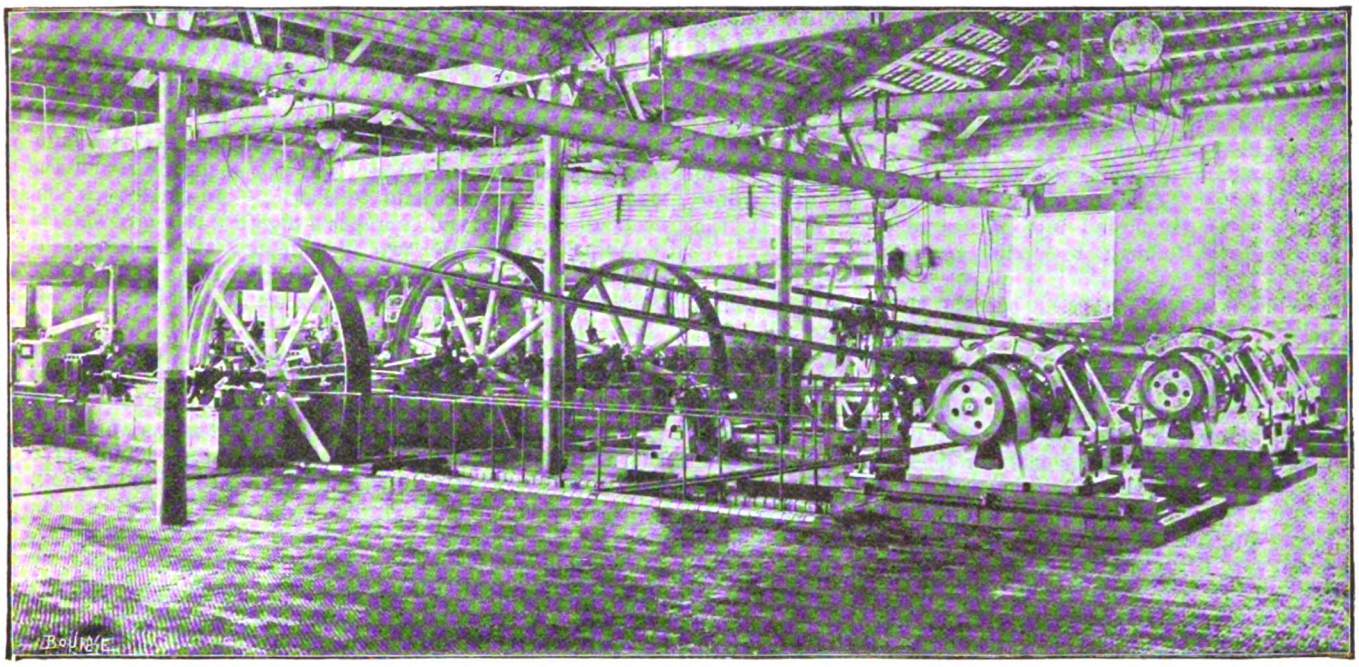

FIG. 1.—Interior of the Hong-Kong Electric Lighting Station.

off in two steps or terraces, on the upper of which the engine-room is built, and on the lower the boiler-house, stores, and offices. The engine-room is about 100ft. long by 75ft. wide, and contains five horizontal compound

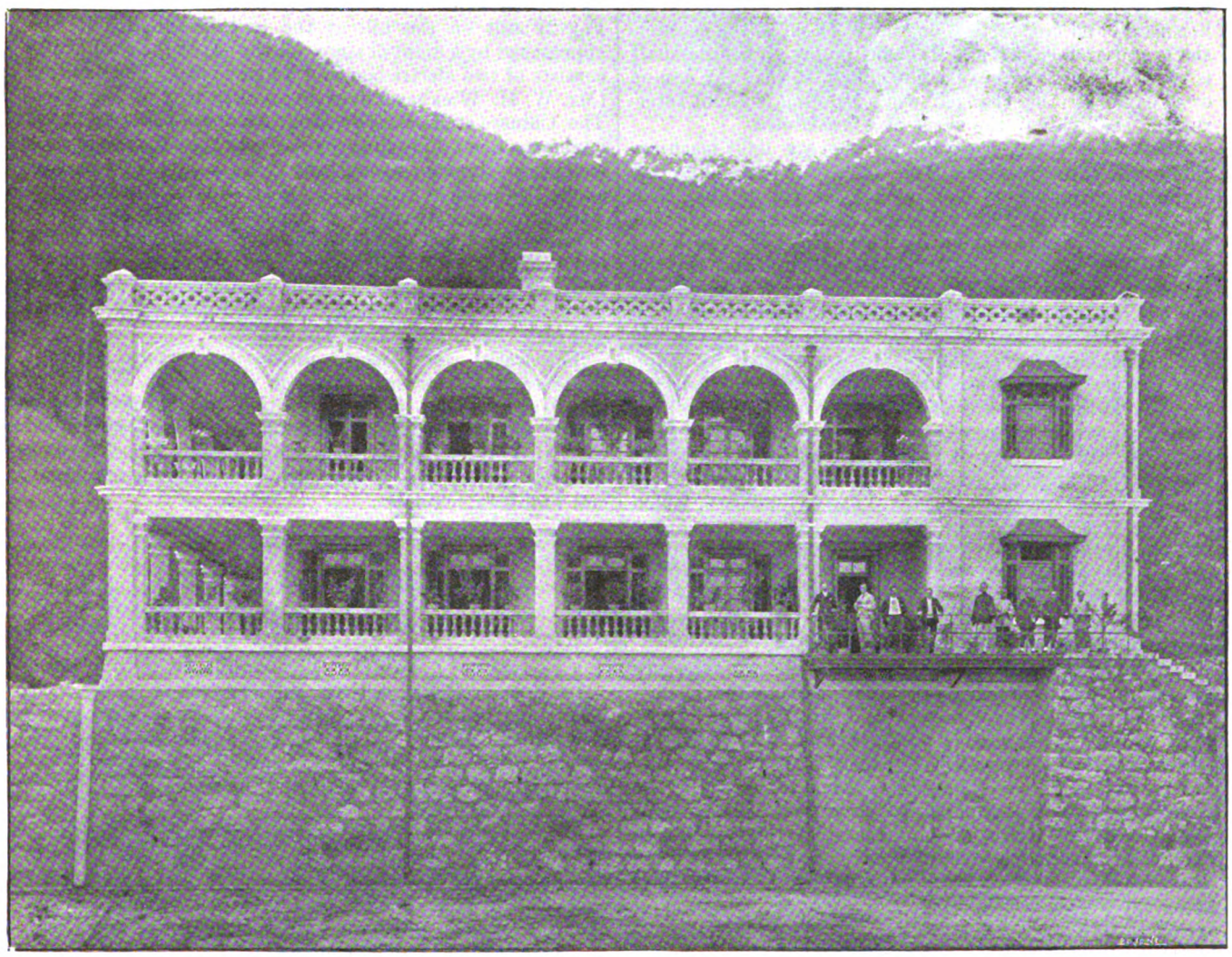

FIG. 2.—The House provided for the Staff of the Hong-Kong Electric Lighting Station

The station is situated at the east end of the town of Victoria, Hong-Kong, in the Wanchai district. It is built on the side of the hill, just below the aqueduct which supplies Hong-Kong with water, the ground having been cut engines of 90 nominal horse-power, with jet condenser at back of low-pressure cylinder. The engines run at 100 revolutions per minute. The flywheel, which is between the high and low pressure engine, is 13ft. in

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diameter, with six grooves on the face for driving ropes 1¼in. diameter, leading direct to the countershaft for driving the dynamos. There are two patent feed-water heaters. The water supply for the condensers is obtained from a tank about 75ft. by 50ft. by 8ft. dug out of the hill at the back of the engine-room, and fed by a small stream from the hills. The boilers are also supplied from this tank, but during the dry season from the town supply. The cold water from the hills run in at the bottom of the tank, and the supply to the condensers is also taken from the bottom. The water after being used for condensing purposes is discharged into the same tank, but at the surface level, to facilitate cooling, and is used again.

The boiler-house, which is on the lower level, is reached by a flight of stone steps. It contains three steel Lancashire boilers with Galloway tubes. The boilers are 26ft. 6in. long, and are worked at a pressure of 140lb. to the square inch. They are supplied with water both by injectors and two donkey pumps. As a rule only one boiler is in use, but a second is kept under steam in case of accidents. There is a large space for coal storage alongside the boilers. The flue which passes along the back of the boilers passes through the wall and into the chimney shaft, which is 75ft. high. Japanese coal is used, and although rather smoky gives very little trouble in keeping steam. Next to the boiler-house is a store for cables and line materials, and there is also another large store fitted up with shelves all round, and having a gallery round it for the storage of electric light fittings and glass. There is a small office fitted up for testing and for regulating and testing the meters for the house supply. The alternating meters are of the shunt type. The three arc light dynamos, which are fitted with automatic regulators, are each of 55 lights capacity, and are run off a countershaft by belts. Two horizontal and one vertical engine work on to the countershaft, and each engine and dynamo pulley on countershaft is controlled by a patent friction clutch, so that any engine or dynamo can be changed while running without interrupting the lights in the event of a breakdown.

There is a spare armature for the arc light machines which will fit any machine. The alternators are 50-kilowatt Kapp type running at 650 revolutions per minute, with 75 ⁀⁀ and giving 2,000 volts, and are placed on slide rails with shifting screws, and bolted down to solid brickwork and granite foundations. The arc light dynamos are laid on baulks of timber bolted down to brickwork foundations, and the machines are surrounded by a wooden platform on oil insulators to guard against the danger of shocks to the dynamo attendant. The alternators are excited by Kapp dynamos giving 50 amperes and 150 volts, which are driven by belts off the alternator shafts. An overhead travelling crane runs across the engine-room for handling the heavy parts of the machinery. Johnson and Phillips transformers, transforming from 2,000 to 100 volts, are used in the houses for private lighting. The switchboard, which is at the back of the engine-room, is of teak and is about 3ft. away from the wall, thus allowing access for connecting up the leads. All the instruments are mounted on enamelled slate slabs, arranged one for switch gear for the alternating circuits, two for fuses for the same, one exciter circuit board, and one one-light circuit board.

Lightning arresters of the magnetic air-gap type are placed on each pole of every circuit leaving the switchboard to protect the dynamos and instruments. These were adapted in preference to the brush type, which did not answer in the severe storms which Hong-Kong is subject to, and it was no uncommon thing to have the arc circuits struck and short-circuited 20 or 30 times in an hour during a heavy storm. Sometimes it was impossible to keep the incandescent circuits going, as the fuses were blown as fast as they were replaced owing to the lines being repeatedly struck. However, after the adoption of magnetic arresters in the station and Wurtz arresters at intervals along the lines there were seldom any mishaps. In front of the switchboard is a platform laid with rubber mats and guarded by a rail to guard against accidents from shocks. Each arc light machine has also a patent regulator on the switchboard.

The principal streets are lit by 80 double-clutch non-focussing Brockie-Pell arc lamps. These are fixed in carriers with a reflecting hood, and placed on top of iron lattice poles 40ft. high, except in a few cases, where shorter poles were found necessary. These posts carry wrought-iron brackets, on which are fixed insulators to carry the cables both for the arc lamps and incandescent circuits. Wrought-iron taper poles, with cast-iron bases, are also used for carrying the leads. Johnson and Phillips patent fluid insulators are used for carrying the stranded steel bearers. The cables, which are $^{7}/_{16}$ stranded wire, are high-insulation vulcanised rubber, and are suspended from the steel bearers by porcelain insulators. An earth wire connects all the posts and lamp-posts together to guard against lightning. There are two incandescent and two arc light circuits. The Government House, the Hong-Kong Club, the principal banks, and residences are lit with incandescent light—in all about 10,000 lamps.

In spite of the fact that the overhead wires have on several occasions been damaged by fire and blown down by typhoons, there is no doubt that the company were well advised in adopting the overhead system, as the other alternative of putting the wires underground would have been exceedingly costly, owing to the nature of the ground, which is nearly all solid granite. As it was, many of the holes for the posts had to be blasted out with gunpowder. In connection with the troubles with typhoons, it may be interesting to mention that on one occasion some Chinese junks were blown right up against the sea-wall, and their masts, becoming entangled with the cables which ran alongside, brought them to the ground, together with some dozen posts which carried them. Strange to say, no interruption occurred to the lighting—thanks to the good insulation of the cables—and the station officials were not even aware of the accident until the following morning.

There is a handsome house (shown in the illustration, Fig. 2) built on the hill at the back of the station, and approached by a flight of steps, for the use of the staff, which consists of two electricians and an engineer. The manager (Mr. W. H. Wickham) lives in another part of the town. The Chinese staff comprise about 24, there being two head engineers, one taking duty by day and the other by night; also fitters, dynamo attendants, greasers and stokers, and about 10 linesmen for outside work and for house wiring. There are two Portuguese foremen for superintending the house wiring. The Chinese staff are very intelligent, and soon learn the work and make very good wiremen. The company, being the only electrical engineers in Hong-Kong, have done a lot of ship-lighting and repair work for mail and cargo boats entering the harbour.

The works were erected under the personal superintendence of the present manager (Mr. W. H. Wickham), and have given the most satisfactory and efficient results during the whole period from date of incorporation in December, 1890. In the work of installation Mr. Wickham was seconded by Mr. G. Sanderson, one of Messrs. Johnson and Phillips's engineers.

ELECTRIC MAINS IN PARIS.

BY A. MONMERQUE.

(Continued from page 421.)

In three preceding articles the systems of mains have been described which experience in Paris has gradually condemned—namely, (1) the use of metallic conduits, with covered cables, and without any special precautions in the question of support; (2) earthenware channels; (3) covered cables on iron hooks.

Recent explosions in London confirm what has been said on the subject of metallic conduits. In the interest of the development of electrical industry, it is important to exercise the most minute care in laying mains to guard against accidents, which may in a large town have very grave consequences and throw undeserved discredit on the electric lighting industry in general.

There are at present in Paris only three systems of mains: (1) bare cables in cement conduits, called *caniveaux*; (2) covered cables in underground conduits either of cement or metal; (3) armoured cables.

From the point of view of future development, the last-

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named system excels the others. Some mains at first laid with naked cables have been replaced by armoured cables.

The general situation of the mains in Paris on January 1, 1895, is set forth briefly in the following tables, where the districts are indicated by letters. The lengths given are those of the mains—that is to say, half of the length of the conductors in a two-wire distribution, a third in a three-wire distribution, etc. In the conduit system there are often in the same conduit both feeders and distributors. Then the lengths of conduits with feeders and distributors are separately detailed.

TABLE I.—Bare Cables in Concrete Cement Conduit.

—	Feeders.	Distributors.	Total.
	Yards.	Yards.	Yards.
District A[1]	17,200	51,000	68,200
District B[2]	18,900	36,200	55,100
Total	36,100	87,200	123,300

Observations.—[1] Two-wire distribution in concrete conduits. [2] Three-wire distribution.

TABLE II.—Covered Cables in Conduits.

—	Feeders.	Distributors.	Total.
	Yards.	Yards.	Yards.
District A[1]	765	2,630[2]	3,395
District B[2]	—	15,500[4]	15,500
District C[5]	2,950	2,400[6] + 3,720[7]	9,070
Total	3,715	24,250	27,965

Observations.—[1] Two-wire distribution. [2] Three-wire distribution. [3] Five-wire distribution. [4] In metallic conduits in paraffined wooden cases. [5] Two and three wire distribution. [6] Covered cables on porcelain insulators. [7] Covered cables placed in wooden casings and in concrete conduits.

TABLE III.—Armoured Cables.

—	Feeders.	Distributors.	Total.
	Yards.	Yards.	Yards.
District A[1]	186	219	405
District B[2]	—	1,095	1,095
District C[3]	328	109	437
District D	5,250[3] + 1,860[2]	24,700[3] + 7,000[2]	29,950[3] + 8,860[2]
District E[3]	22,500	54,600	77,100
District F[4]	13,900	52,200	66,100
Total	44,024	139,923	183,947

Observations.—[1] Two-wire distribution. [2] Three-wire distribution. [3] Five-wire distribution. [4] Two-wire distribution (concentric cables).

TABLE IV.—Recapitulation.

System.	Total length of conductors.	Proportional percentage.
	Yards.	
Bare cables in underground conduits	123,000	37
Covered cables in underground conduits	28,000	8
Armoured cables	184,000	55
Total	335,000	100

Various conclusions may be drawn from these tables. We will only remark that all the districts in Paris, some partially, some exclusively, make use of armoured cables. This system of mains offers, in fact, considerable advantages in large cities, where narrow thoroughfares are often met with, already encumbered with other underground networks, notably gas-mains. The cement conduits require a regular position in the street, whilst the armoured cables do not cause any trouble in this respect, but can be laid round obstacles. Besides, they are quickly laid, whilst the cement conduits require to be left for several days to set, which increases the duration of the obstruction to traffic.

Finally, with the use of armoured cables no empty spaces are created under the public road; and, in consequence, the presence of chambers charged with an explosive mixture of air and gas is not to be feared, but with cement conduits or metallic conduits which have good drainage these accidents are to be feared and have taken place. Such casualties can only be obviated by very careful attention to the ventilation of the underground conduits, as is at present given to the question in Paris.

It is as well to remember, moreover, that to-day armoured cable mains are more economical than those on the conduit system. In M. H. Maréchal's interesting work "L'Eclairage à Paris," pp. 229-231, there is a comparison of the prime costs of the various systems. It is shown that a main of three wires of 200, 100, and 200 square millimetres, for continuous currents, 240 volts, costs 31f. the metre with armoured cables and 33f. in *caniveaux*; and that a main of two wires of 60 square millimetres for alternating currents of from 2,000 to 3,000 volts costs 56f. in conduits and 24f. with concentric armoured cables.

It may, further, be noted in favour of bare cables that with them, without much trouble, the density of the current can be augmented, while with armoured cables there would be risk of damaging the insulating material through excessive heating. This consideration, it is true, can only logically be applied to the feeders, for the section of the distributors should be sufficiently large so that between two points of junction with the feeders the loss of voltage may be as little as possible, and, in any case, the question of heating does not need consideration. For the feeders themselves, when the consumption increases on the network to the extent that there may be occasion to think about the density of the current, it will be well to examine if it would not be better to fix a new feeder in place of consuming energy in the form of heat.

In brief, it may be said, with due respect of what experience may be able to teach us in the future, that where large towns are in question, where the exigencies of public traffic make imperative the use of underground cables, recourse as much as possible should be had to cable mains, comprising within themselves and simultaneously the double protection, electrical and mechanical, and placed directly in the ground, of the type called armoured cable.

If, for particular reasons, recourse is had to a system of mains formed of conductors placed in conduits, this method should only be adopted after careful investigation. Especially should the results already obtained be ascertained, and whether or not the conduit is waterproof, and in any case assure the immediate ejection of water if it should accidentally have entered.

The nature of the materials employed in the construction of the conduits should be considered. It would be well, as a rule, to avoid the use of glazed earthenware, and in the case of covered conductors the employment of iron hooks as supports for them.

Recourse should not, in principle, be had to metallic conduits. When their use is obligatory for special reasons, the cables in them should be insulated with the same care as if they were placed directly in the ground.

In the case of underground conduits it is as well to pay particular attention to their ventilation, and to prevent the accumulation of explosive mixtures of air and illuminating gas.

Finally, in every case steps should regularly and periodically be taken to measure the insulation of the conductors

USES OF ACCUMULATORS.*

BY J. C. HOWELL.

When I was first asked by one of the members of your council to prepare a paper upon accumulators, I was much concerned as to the course I should take, whether I should cry off on the ground that it was useless raking up the ashes of a dead industry, or boldly enter the vault in which low tension had been entombed, and seize what relics I could to bring before you of the wisdom of the ancients. Finally, I chose the latter course, and my investigations have been rewarded by the discovery of a leaden scroll upon which had been traced, evidently electrolytically, in characters of peroxide a long poetic prophetic account of the final triumph of electric storage systems, a rough prose translation of which I shall attempt to give you to-night.

The scroll commences with a long historic account of the

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birth of the first electric storage systems, describing in turn the early experiments of Gautherot, Ritter, Gaston Planté, with his leaden plates; Grove, with plates of oxygen and hydrogen fitted with platinum electrodes; Faure, Sellon, Volckmar, and a host of others, chronicles the historic passage across the channel of the box with its 1,000,000 foot-pounds of stored-up energy, and finally settles down to the sober consideration of the chemical actions involved in the charge and discharge of the cells, as the new boxes were styled. One cannot help admiring the ingenuity of the old scribe in twisting into proper rhythm long lists of chemical formulæ, but with these we shall not concern ourselves to-night, but hasten on to that portion where the uses to which accumulators were put are described with more or less detail, as being far more interesting to the majority of us who are, I understand, more connected with the practical development of electricity than with its theoretical and mathematical aspect.

The first uses to which these accumulators were practically put was for maintaining continuity of supply, or what is now called constant service, in country house electric lighting work. In the very early days of electric lighting it was discovered that in this class of work it was essential that the light should be available any hour of the day or night, and that people were prepared to pay considerable sums for the use of an apparatus which would give them this regularity of supply, and so avoid the necessity of keeping a man or men continually looking after moving machinery. Although the capital cost of these early accumulators was exceedingly high, it was speedily found that the annual saving effected by their use was sufficiently large to recompense the purchaser for his outlay, except in cases where water power was available. In gas-engine work, and with steam-engines, the accumulators were found to be working at their best efficiency at a time when, had the motorial plant been in operation, it would have been working at its worst efficiency, and instances are recorded where, by the adoption of accumulators, the gas bill had been reduced to 50 per cent. of what it was when the supply of electricity for household service was obtained from the dynamo driven directly by the engine, and this difference in a case where the former supply had not been constant service.

Unfortunately, the construction of these first accumulators was defective, and for a while accumulators became discredited owing to the frequent breakdown of the plates of which they were composed, and the falling away of the active material which permitted what we shall call the storage action to take place. By slow degrees these faults in construction were discovered and remedied. Then a more abstruse series of faults developed—viz., those due to the peculiarity of the chemical actions which were going on in the cell, and which required time to show themselves. These, too, in turn were carefully investigated by earnest men, who devoted their lives to research, until at last, by the law of the survival of the fittest, manufacturers were able to produce accumulators which they were prepared to guarantee and maintain for a series of years.

During this period other departments of electrical industry had not been idle, and the electric light had become so popularised that central stations were established for the supply of electricity. The public were at first contented with a supply which would suffice for the ordinary hours of lighting, but as they began to appreciate the benefits of the new illuminant they were not content with a partial supply, but required it at all hours of the day or night, and men's minds were directed to find some means for providing this supply in an economical way. Had the public been content to maintain their demand for lighting at a normal rate whenever they required it, it would have been easy for the central stations to supply electricity in an economical manner, but the public, proverbially fickle, required their supply in an extraordinary fashion. At certain periods of the day they were content to ask for only some 1 per cent. of what their normal demand was, and, moreover, required that the supply at this period should not be charged for at a higher rate than when the demand was just 100 times in excess. Although it had struck many long-sighted engineers that the public supply of electricity would have to be dealt with finally in much the same fashion as the public supply of water or gas had been dealt with, no one, the scroll narrates, had realised how greatly the demand for lighting at different times of the day varied, and the ordinary engineer greeted the publication of the first load curve of a central station that was published with a smile of wondering bewilderment. Such curves in the after history of electric lighting became common, and comparisons were instituted between curves obtained for various districts, various cities, and various countries, and it was found that there was a very considerable amount of uniformity throughout the world. In process of time, the different characteristics of the load curve for summer and winter were established, and it became more and more evident that, unless some satisfactory means of providing for this inequality of demand was discovered, electric lighting would for ever remain a luxury.

The accumulator manufacturers considered that they held the key to the solution of the difficulty, and at Colchester set down a system which was intended to demonstrate to all the world that the difficulty had been satisfactorily met. The problem was, however, unfortunately tackled by men who were probably thoroughly conversant with the batteries manufactured at the time, but had very little knowledge of the public needs, and after some years' work the scheme had to be abandoned, and other methods tried. The scheme had, however, in showing the difficulties to be encountered, shown also considerable promise for the future, and it was discovered that accumulators, to be of real service in central-station work, had to be capable of meeting for short periods demands considerably in excess of their normal capacity. This was difficult of attainment, as, owing to the chemical actions taking place on the plates which formed the active portion of the accumulator, any supply of electricity drawn at too rapid a rate would tend to break down the materials which composed the plate; and, furthermore, did not provide sufficient time for the electrolyte to diffuse itself so as to keep up the chemical reactions involved in the supply of electricity. This fact being properly appreciated speedily led to the development of accumulators which could, on being called upon, discharge at very rapid rates, and, although these accumulators were costly, it was discovered that their freedom from breakdown in trying circumstances was such as to warrant a trial being made on a sufficiently large scale to see whether this new form would be fully equal to all the requirements of central-station practice. Reliable statistics, too, were at this time available, so that engineers could fully realise the costs of working under the peculiar conditions which the public demanded, and it was found that the cost of fuel was from four to six times what had been expected from the results obtained when working an engine and dynamo under test. The facility with which electrical measurements could be made had trained men's minds for the investigation of the various losses occurring in the transformation of energy, and central-station engineers became more and more aware of the necessity of dealing with all these losses so as to enable them to compete on more and more favourable terms with other systems of illumination that had been in vogue.

A discussion upon these sources of loss and the way in which by the use of accumulators these losses can be minimised is the real object of the leaden scroll, and to make matters clearer I have placed before you to-night curves of the efficiency of a steam-driven dynamo at various loads, from which you will see that the quantity of water required to be evaporated per unit working at 20 per cent. of its load is more than twice as much as when it is fully loaded, the figures being 33lb. of water per unit at full load and 73lb. at one-fifth load.

NON-CONDENSING WILLANS SET.

Engine load-factor.	Pounds of coal per unit.	Cost per unit of coal at 20s. per ton.
20 per cent.	7·3	·78d.
30 ,,	5·4	·57d.
40 ,,	4·75	·5d.
50 ,,	4·3	·46d.
60 ,,	4	·43d.
70 ,,	3·75	·4d.
80 ,,	3·5	·37d.
90 ,,	3·4	·36d.
100 ,,	3·3	·35d.

Similar engines, when dealing with the business of supply, have been tested by Prof. Kennedy at actual work, and he has been good enough to publish his results. These results I have embodied in a table, to which I shall refer you, and I have amplified them somewhat so as to give us sounder ideas of what the figures actually mean by attaching a value to the ton of coal. This value may appear high to you in this district, but it is the price that rules in London, where at the moment there is a greater production of electrical energy for lighting purposes than in all the rest of the United Kingdom put together. Moreover, it is a comparatively easy matter to mentally reduce the figures of the table based on a standard price of 20s. per ton to the figure which rules in each investigator's district.

KENNEDY TABLE OF CONSUMPTION ON VARIABLE LOADS.

—	11 a.m. to 6 p.m.	6 p.m. to midnight.	Midnight to 11 a.m.	Whole day.
Time	7 hours	6 hours	11 hours	24 hours
Total indicated horse power-hours	562	1,366	407	2,335
Total electrical horse-power hours	400	979	260	1,639
Units generated	293	731	193	1,217
Coal consumed	3 838lb.	4,459	2,547	10,844
Coal per unit	13 1lb.	6 1	13·2	7·33
Coal at 20s. per ton	1·4d.	·65d.	1·41d.	8d.

Take as an example of the use of Table I. that we have 100-unit steam dynamo running at maximum efficiency. It will need under the most perfect conditions of running 3·3lb. of coal per unit per hour, or 330lb. Increase the load upon our station 20 per cent., and we have to start another similar set, so that

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the load is divided between them; each set is now working at 60 per cent. load-factor; the amount of coal consumed is 4lb. per unit, or 480lb. Thus an increase of 20 per cent. in the load involves an increase of 45 per cent. in the coal consumption, and the actual loss owing to the decrease in efficiency is 9½d. per hour in the coal bill alone as long as the 20 per cent. extra load is maintained. That these losses are real and are actually found to exist in practice we will at once discover by reference to the Kennedy table, where we find that there was less coal burned during the period of heavy load than during the period of lighter load—that, in fact, 63 per cent. of the total amount of fuel consumed was used to provide 33 per cent. of the output. It will be of interest if we examine this table closely. The day on which these tests were taken was divided into three parts closely corresponding with the times as shown on a load curve where you have a minimum demand, moderate demand, and maximum demand. You will notice that the amount of coal required for the moderate demand approaches very closely to the total amount required for the maximum demand, and that during the period of minimum demand, when only some 20 per cent. of the maximum output was delivered, the coal bill reached the respectable figure of 57 per cent.

Let us pursue our investigations a little further, and we will see that during the period of lighter load 6,385lb. of coal were consumed, an amount sufficient working at the rate shown during the period of maximum demand to produce 1,050 units, or very nearly the total daily output required. Had we been therefore only able to provide some suitable means of storage which would have allowed us to run our engines at a fair rate of economy, there was a possible chance on that day's output of effecting a saving of two tons of coal during the run, or, say, £2 sterling, an amount which would perhaps go some little way towards meeting the resident engineer's salary.

That there is a practical difficulty in so running a central-station plant as to work at anything like a fair efficiency, no one but a central-station engineer has fully realised, and I should like here to emphasise what I have long felt, that we hear too little of the central-station engineer. It may be that the exigencies of his work preclude him from attending meetings and speaking thereat, and I can well understand that the problems continually thrust upon him absolutely forbid his devoting much time to writing papers, but if he only realised what service he could render to the manufacturers, who are always anxious to supply him with what he wants, he would, I think, strain a point, and give the world knowledge of his necessities. To give you some conception of the problem that the resident engineer has to solve, I have prepared a diagram showing you the output of an American station which I visited some time ago, and I have plotted in the way in which the load was dealt with.

The plant at their disposal was capable of dealing with a maximum output of some 18,800 amperes made up in four sets of 2,000 amperes each and nine sets of 1,200 amperes. You will note from the marginal scale at the side that at no time during the day did the station touch an engine load-factor of 80 per cent. except for a few minutes at the peak of the diagram. I have coloured the various engines so that you can more clearly observe what happened during the day. You will see that, starting at one o'clock in the morning, set No. 15, coloured black, was kept running nearly the whole 24 hours; that set No. 11 ran from one o'clock till half-past nine, and, if you carefully note the level that No. 11 set, combined with No. 15, would have taken, you will observe that during the whole period of minimum demand the engine load-factor did not reach even 60 per cent. as an average. You will further observe that at seven o'clock, when the load commenced to rise, the additional load had to be dealt with by adding small set after small set, and it was only when the load was rising so rapidly near the peak were they able to fully utilise the larger sets which ought *a priori* to be more economical to run than the smaller sets. The same criticism will apply on the down grade when the demand was decreasing. The coal consumption at this station on the day on which the curve was taken was 80 tons. On further reference to this curve, you will see that the two larger engine sets were kept going at as near their maximum output as in American practice is considered safe, taking the sudden abnormal changes of load into account, and that the balance of the load was equally divided over all the other sets that were at the time running. The result of this complicated system is that although by the number of engines running the efficiency of each is somewhat increased, the regulation of the pressure on the mains is more difficult, as the adjustment to standard is only really effected when the current from the last machine is properly adjusted. That the labour involved in this adjustment is considerable is easily understood on reference to the diagram.

Reverting once more to the leaden scroll, I find that almost all our later knowledge with regard to the varied load-line had been duly considered, and methods are described very fully by which the use of accumulators would relieve the central-station engineer from all anxiety as to his variable demand, and following closely the instructions laid down in the scroll, I have prepared a chart showing how the methods there described would deal with the load curve which I have put before you. We are told that we must first ascertain the output for the period of minimum demand, and for what time the minimum demand lasts. These figures enable us to ascertain the capacity of the accumulators required. We observe that this period of minimum demand is very clearly defined on our load curve as lying between 1 a.m. and 7 a.m., a period of six hours. During this time an average of 2,100 amperes have been delivered to the circuit or, say, in round figures, a total of 13,000 ampere-hours. To provide for this output and allow a margin for contingencies, we shall require a set of accumulators having a capacity of 14,000 ampere-hours. An enquiry addressed to modern accumulator manufacturers has brought me the information that such a battery would cost delivered and erected £7,000.

On adding this battery to the equipment of the station and closely observing the rules and regulations laid down in the scroll, I find that the result upon the working of the motorial part of the machinery is that whenever an engine is started it can be kept at full load from the moment it starts to the moment it ceases running, thus bringing up the efficiency of the station to 100 per cent. engine load-factor at once.

Observe the result on the load diagram. Instead of the patch-work jumble of in and out engine loads, we have each set working steadily at full output as long as is required; that the hours of running have been shortened from 24 to 18, thereby lessening the number of men employed. More than this, we have been able to commence running with three of our large sets at full load from the moment of starting up to 7 a.m., and that these engines run steadily throughout the day. We notice also that when the load increases, the accumulators, although discharging during the early morning hours, have already received sufficient charge to permit a discharge until three more engine sets can be started simultaneously, pointing out the advisableness of employing fewer sets of larger plant for this station.

The only regulation required is the steam pressure at the boilers, which must be kept constant, and a slight increase in the speed of the engines as the load creeps up to compensate for the slight additional loss in potential in the feeders leading the current away from the station.

Follow the curve still further, and we come to a period when the engineer has to exercise his judgment as to whether he will let his battery deal with the peak or run one of his engine sets. He chooses the former course, and to provide for it he starts his blue set, and keeps it running for several hours before the peak actually occurs. You will observe that at the time when this peak is about occurring, he again starts three sets simultaneously, and the peak itself is allowed to come from the battery. Three times during the day, therefore, has he to start some plant, and in each case you will observe that he has been able to put on three sets. Only once is it necessary for him to start one of his engines alone.

Now, I shall very probably be told that, owing to the variation in the E.M.F. of the battery during charge, the regulation of the charging current will be an exceedingly difficult matter. A diagram carefully copied from the leaden scroll will show at once how exceedingly simple this regulating matter is. One of the steam-dynamo sets is expressly made to give just the current rate necessary for properly charging the battery and no more. The set devoted to this work in the station before us is the black No. 15. This set is capable of charging the battery at 2,000 amperes, and the dynamos are so wound that, when necessary, higher volts can be obtained from this set than from the other sets. It is the first to be started up and it is the last to leave off, and is during the whole day prepared to charge the battery except at the time when the output called for is in excess of the current generated by all the sets in combination. It is kept permanently attached to the regulating ends of the battery, as you will see from the diagram. An adjustable switch is so arranged that the terminals of the machine can be attached to any cell in the regulators, so that as the end cells get charged up the switch may be moved down until it reaches the cell which is in connection on the discharge side with the terminals of the other sets and with the circuit.

You will note, also, that the loss in charging the accumulators is very slight, as it is only felt by one unit of the plant, and is really in the load diagram before you only 1 per cent. of the total load delivered to circuit, as the proportion between the load dealt with by the accumulators and the total output is just slightly over 8 per cent. But what have we gained? Even the most casual glance will show you how immensely simplified the station work has become—a certain number of engines running, a certain amount of steam required, the engineer in charge directing everything with quiet confidence, knowing full well that he has a big reserve always behind him capable of dealing with an extraordinary demand or with any little accidental occurrence, such as a hot bearing or low steam pressure. In a well-regulated central station, with a becoming amount of pride, such accidents should, I am aware, never happen, but I am credibly informed that they do sometimes occur.

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But these, after all, are only minor advantages. No board of directors has yet, as far as I am aware, sanctioned an item for depreciation of engineering staff appearing on a balance-sheet, and we must look for more solid grounds of economy before we can appeal to them. A comparison made between the two curves will at once show you that the labour bill will be considerably reduced by the employment of accumulators, and the amount of the saving is thus shown by Table 2 to be £1. 15s. 6d. a day.

STAFF REQUIRED TO WORK CENTRAL STATION.

Without accumulators.				With accumulators.			
10 greasers at 4½d	... £1	7	6	8 greasers at 4½d.	... £0	18	8
6 engineers at 8d.	... 2	0	0	5 engineers at 8d.	... 1	10	0
11 stokers at 5½d.	 2	10	5	9 stokers at 5½d.	 1	17	1
3 switchboard attendants at 8d.	 0	16	0	3 switchboard attendants at 8d.	 0	16	0
				2 battery men at 8d..	0	10	8
30	£7	3	11	27	£5	12	6

Difference—£1. 15s. 6d.

The coal bill will also shrink, as we have ceased running our engines during the period when we are using our coal most wastefully, and, moreover, we are able to run our engines at full load whenever they are running. Carefully working out the amount of coal required for each engine, we shall see that we have brought down the amount from 80 tons (which I have mentioned as being the amount consumed on the day on which this load curve was taken) to 67. Our oil bill and petty stores have also been reduced in almost the same proportion, and it is probable our bill for repairs to the motorial portion of our plant will be decreased somewhat, although this I will not at present take into account. You will also have observed in your comparison of the two curves before you that three engines that were at work in the first curve have not been required to run at all in the station when fitted with its accumulator system. We thus save the lubrication bill on these engines entirely, and the saving has been therefore:

Labour bill	£1	15	6
Thirteen tons of coal	13	0	0
Lubrication, say		4	6
Repairs		—	
	£15	0	0

But in order to effect this saving we have been compelled to make an outlay of £7,000 in a class of plant which, in the minds of most engineers, should submit to a heavy charge for depreciation. We have not forgotten this, and will therefore set aside a sum sufficient to meet the views of these engineers by putting on the other side of our account an amount of £2 per day for depreciation and £1 per day for interest on the outlay.

The extra staff required to look after the accumulators has already been dealt with in our labour table. The net saving therefore is reduced to £12 per day, or, say, £4,380 per annum, an amount sufficient to wipe off the whole capital cost of the accumulators in two years, and still leave a margin to go to the profit and loss account. The load curve you will see is dated June 23, and you will readily understand what this means.

Now these figures are facts, and can be proved up to the hilt. They do not admit of argument, and since they apply to a station arranged on a scale very much larger than anything we have hitherto built in this country, they effectually dispose of the usual modern criticism that accumulators may be very well adapted for small stations, but are absolutely inapplicable to supply stations dealing with large outputs.

Another criticism, and a fairer one, would be that by taking coal at a value of 20s. per ton I have exaggerated the saving on the capital outlay. This is true, but those who care to puzzle out the problem will find that the economy is sufficiently marked at any value for coal to warrant the adoption of accumulators, and they will also find that the only satisfactory method of doing away with accumulators entirely is to work up their demand curve to a straight line extending over the whole 24 hours, an occupation which the old scribe quaintly observes "will take them all their time."

It will be seen, therefore, that wherever there exists an intermittent demand for a supply of electricity an electrical storage system is a necessity, unless the cost of the initial power is so abnormally low that the interest charges on the accumulator outlay amount to more than the annual saving to be effected. Such causes do sometimes occur when an abundant supply of water is available close at hand.

Intermittent demand for power is the rule in the majority of our manufactories to-day, and although hitherto we have been content to meet this demand by transmitting our power by means of steam-pipes, countershafting, and belting, the day is not far distant when electrical methods of transmission will be the rule and not the exception. In all these cases the leaden scroll is emphatic in pointing out the application of accumulators, and you will readily perceive from what has already been said that to obtain the utmost economy accumulators will be absolutely necessary; for they enable us to reduce the initial power put down, and, furthermore, permit us whenever the utilisation of the power takes place some distance from the spot where it is generated to economise in the conductors, as they need not be of a sectional area greater than will carry the average current instead of the maximum with efficiency.

In this district, where underground transmission of power is becoming more and more common in all your collieries, you will assuredly find in the near future batteries of accumulators installed in the underground galleries in chambers such as you see on the wall, the difference in value of the highly-insulated conductors leading in-bye having been found to cover the cost of the system of storage, without taking into account at all the other economies found to exist in the maintenance of the plant. Already electric railways have adopted electrical storage systems for equalising their load and maintaining more equal potential over their lines, thus ensuring a regularity of train service not to be attained by any other means.

I could go on quoting from the scroll, pointing out numberless other instances where accumulators would be of the greatest service, but our time is already far spent, and I shall not weary you to-night by elaborating the matter further. There is, I think, a sufficient basis of fact on the scroll to warrant our seriously considering whether the methods we are to-day adopting for dealing with the electrical supply of towns are in the majority of cases the most suitable methods, and I feel sure that the question of coal economy has not been gone into with anything like the care it should be in the design of many stations now at work and in course of construction. The high coal bill shown in many districts where coal is cheap is sufficient evidence of this. I trust, therefore, that the discovery of this scroll may be of some slight service in drawing the attention of the younger members of our profession to a closer study of this question, and I shall be only too pleased if the discussion on the points raised will lead to greater interest being taken in the subject.

TELEGRAPHY BY INDUCTION.

Mr. W. H. Preece delivered an address with this title yesterday (Thursday) before the members of the London Chamber of Commerce in the hall of the Carpenters' Company, London-wall. Sir Albert K. Rollit presided. The lecturer said that he had adopted this title to distinguish the subject of his address from "telegraphy by conduction," the common mode of working. He referred to the efforts of Morse in 1842, and of Lindsay in 1854, to solve the problem of telegraphy by induction. One of his earliest experiments was made for Lindsay in that year. "Telegraphy by induction," he said, meant signalling through space by electromagnetic waves without any conductor joining the points between which communication is desired. A somewhat analogous process was the use of the heliostat in India, by which signals flashed by the rays of the sun conveyed information from Chitral to the relieving forces. In this latter case the instrument that received and translated the signals was the eye, but in the experiments that were then being discussed the receiving instrument was the telephone, an exquisite apparatus of precision and research, as well as a simple instrument of utility. If Faraday had possessed the telephone, electricity as a science would have been advanced perhaps a quarter of a century. In 1884, his interest was excited by the fact that an operator in a telephone company's exchange-room in the neighbourhood read some messages that were being sent to Bradford from the General Post Office through a wire in an iron pipe laid underground in Gray's-inn-road, although the telephone wire ran along the housetops 80ft. away. An exhaustive series of tests and experiments proved beyond all doubt that this was a case of pure induction. Space was filled with a medium, called the ether, through which numerous waves of energy—radiations—were propagated with the same velocity, but in different forms and with different frequencies. At one end of the scale extremely minute radiations undulating many million times per second gave us photospheric effects; others less rapid gave us light; then we had radiant heat, and when we came down through a great range to a few hundred per second we had electromagnetic waves which obeyed the same laws of reflection, refraction, interference, and polarisation. We had to regard (1) the source of energy—the transmitter; (2) a medium for the transmission of the radiations; and (3) an instrument to transform the radiations back to the original form of energy—the receiver.

The lecturer next spoke of Faraday's discovery of electromagnetic induction, the principle of many valuable inventions, but Faraday (and the lecturer assisted him in his enquiry) tried to find these currents in our telegraph wires and failed. He (Faraday) knew they were there, but he could not trace them. They were subsequently found in long parallel wires in dry climates, like those of India and Persia, but it was not until 1884 that they were traced with certainty, and that was in Gray's-inn-road, London. The fizzing, frying sounds in other currents so annoying in our telephones were due to this induction. In 1885 an induction experiment in the neighbourhood of Newcastle traced the effects to a distance of 2,000ft. Distinct speech was carried across a space of a quarter of a mile. In 1886 experiments in the valley of the Severn measured disturbances through a distance of 4½ miles. The wide expanse of sand on the South Wales coast, well covered by the tide, enabled experiments to

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be made in air and water, and showed that the inductive effects were equally observed in each, and in 1892 actual messages were sent across the Bristol Channel from the mainland to Flatholm. Subsequently, speech by telephone was easily maintained across Loch Ness, on the Caledonian Canal, a distance of 1¼ mile. Later, signals were passed between Arran and Kintyre, four miles apart, but the final practical success was obtained in March last. The cable connecting the Island of Mull with the mainland near Oban having been broken, it was decided, pending the arrival of the cable-ship charged with repairs, to establish communication across the channel by this means. The width of the channel at the point selected for the inductive circuit varied from 1¼ to 2 miles, and skirting the coast of the island an overhead wire existed between Craignure and Aros in a position well adapted to the object in view. The distance between this wire and the mainland was almost uniformly two miles. As there was no existing wire on the mainland parallel with and sufficiently close to the Aros-Craignure circuit, a guttapercha-insulated wire was laid along the ground from Morvern in a north-westerly direction for a distance of 1½ mile. It was earthed at Morvern in a running stream nearly a mile away from the sea, at the other end in the sea.

The apparatus connected to each wire consisted of (*a*) a rheotome or make-and-break wheel, capable of causing 260 undulations per second; (*b*) an ordinary battery of such voltage as to send a sufficiently strong current through the circuit—in this case dry cells were used for portability; (*c*) an ordinary Morse key; (*d*) a telephone to act as a receiver. The rheotome consisted of a small electromotor driving a divided disc that rapidly made and broke the current the requisite number of times. It was joined in multiple with the line and the main battery. Good signals depended on the rapid rise and fall of the primary current; this intermittent current was broken up into Morse signals by means of a key, these signals being read on the telephone connected to the opposed circuit. Communication was satisfactorily established on Saturday, March 30, although, owing to the fact that telegraphic communication was possible did not become generally known till later, only one message was transmitted on that day. Up to and including Wednesday, April 3, a total of 156 messages was despatched, including one Press message of 120 words. The cable was repaired on the last-named date, and the ordinary method of transmission resorted to. The official at Mull reported, "I do not think an ordinary Morse circuit could have given better results." Curiously enough, he also reported that "the chief difficulty was the incessant screaming of the sea fowl," while "strong earth currents interfered very much." He (Mr. Preece) attributed the "screaming of the sea fowl" to a very different effect. Strange, mysterious, weird-like sounds were frequently heard on long lines of telegraph in the calm stillness of the night, but whether they were due to terrestrial or to cosmic causes remained to be discovered. The sun's photosphere when disturbed by spots might be subject to violent electrical storms, and those vast clouds of incandescent hydrogen that flamed up with terrible velocity might excite electrical oscillations through ethereal space of such a frequency as to influence our terrestrial circuits. We might thus hear on earth the electric storms of the sun. It was difficult (the lecturer concluded) to forecast the future of this new telegraphy, we had signalled in one direction only, but there was no reason why we should not duplicate and quadruplicate our messages. Each particular circuit had its own sympathetic frequency, and each telephone responded more energetically to one particular note better than to any other, and we could take advantage of these two facts.

INSTITUTION OF ELECTRICAL ENGINEERS, May 23.

MR. R. E. B. CROMPTON (President) in the chair.

At last night's meeting of the Institution the following candidates were balloted for:

Foreign Members.—Clarence L. Cory, University of California, Berkeley, California; Albert Petersen, Norwegian Government Telegraphs, Arendal.

Member.—Alfred Dickinson, 120, Colmore-row, Birmingham.

Associate.—F. Z. Maguire, 70, Oxford-street, W.

Student.—Charles Flindell, Faraday House, Charing Cross-road, W.C.

The discussion on Mr. Mark Robinson's paper, "On the Recent Development of the Single-Acting High Speed Engine for Central Station Work," was resumed by **Mr. Siemens**, who stated that with regard to the Newcastle tests made by the speaker, to which the author had referred, it should be borne in mind that they were conducted in connection with the first Belliss engine made, and that doubtless better results could now be obtained.

Mr. Chandler said, with reference to the author's remarks regarding slide-valve rings, that it would be very interesting to all advocates of piston valves to know what really were the conditions of pressure at the back of the rings.

Mr. Morecambe took exception to portions of the author's paper. His firm, he said, had an engine at least as good as the Willans, and he hoped to prove this statement. The engines in the Navy for electric lighting purposes were, at one time, nearly all single-acting engines, but the Admiralty was now permitting double-acting engines to be used at the same time. He had heard a friend in the Navy say that they had not time to properly repair Her Majesty's ships, as the Willans engine absorbed so much of their care and attention, owing to collapses. The double-acting engines had not shown these breakdowns. Comparing the single-acting engine with the double-acting engine, there was always the fact that when you had twice the area of the piston there would be a strain along each rod, and, under ordinary circumstances, double the wear. There was not a halfpenny between the two engines as far as economy was concerned. As to durability, he referred to the very numerous parts of the Willans engine, especially the rings, as a drawback in this respect. As to governing, this was a point to which his firm had turned their attention during the last three months. The double-acting engine governed quite well enough. With respect to vibration, there was no reason why the three-crank double-acting engine should not be equal to the single-acting engine. He advocated an impartial trial of the respective merits of the two engines.

Mr. Wright, who had used Willans engines to the extent of 2,000 h.p., had nothing but praise for them. In all his experience he had never had a mishap. He had absolutely no fault to find with them. The whole of the horse-power was managed by two men and a boy.

Mr. H. Halpin, referring to the 90 to 94 per cent. efficiency claimed for the common engine, said he could certainly not believe in figures of that kind unless he had means of verifying them.

Mr. Geipel enquired whether it was correct to state that the high-speed engine would last as long as the slow-speed machine, and whether the early renewal of the one would not balance the increased first cost of the other. Was not, moreover, the method of overcoming the vibration indicated by the author a further argument in favour of using the slow-speed engine for light loads?

Mr. Shoolbred had seen the Willans engines working from time to time, but could not eulogise them like Mr. Wright, as the throttle valve was a blemish. The engine must be kept fully loaded in order to be worked economically. Many arrangements had, however, been made by which the engines could be kept worked up to their mark in central stations from 75 per cent. to full load. At Pontypool the use of accumulators to keep the engines at full load was interesting, but the question arose how much was being paid through the accumulators for this economy. The Willans engine in itself was in many respects more satisfactory in working than double-acting engines, as, for example, in steadiness and silence. The Willans engine was less the engine of the future than of the present, for when one came to large powers, double-acting engines would come into the field,

Mr. R. Allen said that an important point was the crankshaft, as it was difficult to get them made true. The Willans engine was not to blame in the case of Admiralty accidents. He himself had found his engines on board ship had been spoilt by bad management.

Mr. Dumas had had to do with Willans engines on board a man-of-war, and found the interchangeable system a very great advantage. Having discussed the question of the piston rings and the wear in the cylinder, he said that lubrication had a very important bearing on the subject. He wanted to know whether there was excessive wear at the bottom as compared with the top. The mechanical efficiency of the engine would be increased if cushioning could be dispensed with.

Mr. Head also alluded to the lubrication question, and, referring to an experiment he had carried out with a Brotherhood engine, said he had been impressed with the fact that single-cylinder engines were liable to fail unless oil could be pumped in at pressure.

The **Chairman** stated that it was 19 years since he bought his first Willans engine, and he had been using them constantly since. Mr. Robinson had been unworthily accused of seizing the opportunity of discussing high-speed engines to push forward his own, but he was right in giving his own experiences, and not hearsay evidence. He was a friend of the Willans engine as a high-speed engine, for high-speed engines had been the making of electrical engineers. There was no difficulty in taking down the engines and fitting them together again. The makers of enclosed engines were doing the right thing, and he did not mind if they were complicated inside as long as the steam went in and power came out, and there were no difficulties. No doubt the outcry of the advocates of the Lancashire practice had, unfortunately, some influence, but the results would prove unsatisfactory compared with those from high-speed engines. The cost of repairs in central stations was as low or lower with high-speed than with slow-speed engines. There was every reason to be extremely proud of what Thames Ditton, Belliss, Chandler, and other high-speed engineers had done.

Mr Robinson, in reply, said he had not dealt with other high-speed engines, because in central-station work the Willans was the only one which had taken much of a place. It did not require long, as had been suggested, to get at the inside of the engine. Improvements had been credited to him, but he desired to say that such had either been made by Mr. Willans before his death, or had been based upon experiments made by him. He would have referred to the Chandler engine, but little had been published about it. Mr. Morecambe had referred to a duel between double-acting and single-acting engines. This was exactly so, and the speaker was a supporter of the principle of the latter. The air cushion to which Mr. Dumas objected did not receive fair treatment in the navy. There were 100,000 h.p. of Willans engines at work, and they were running without trouble. The economy shown by the Belliss engine at St Pancras was good, but the tests had not been made over an extended period. As regarded durability, there was no sign that there would be any difficulty with the engines in this direction. As regarded the question of light loads, the station, as Mr. Shoolbred had pointed out, should be run so that the engines should not be lightly loaded.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XIV. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers or binding can be obtained, price 2s.

CORPORATION POLICY.

We have emphasised again and again our opinion that the governing bodies of large towns should keep the electric light supply in their own hands, and not allow the monopoly to be in the hands of companies. When they have not done so, but have allowed the new industry to be left to the tender care of so-called local companies, which in reality are controlled by contractors, we do not hesitate in saying that the ratepayers have suffered both in the regularity of supply and in the price charged. The machinery installed by such people is usually selected with a view to the contractor's profit, and charged to the company at full list prices. Still, in some large towns genuine companies have worked provisional orders with a view to dividends to be fairly earned from the supply of electric light. These companies, after years of working, have reached the dividend-paying stage, and convinced the corporations that electric lighting is commercially a success. What follows should be a lesson to all town-governing bodies. The authorities naturally wish to acquire the rights which years before they had allowed to fall into other hands, and also wish to do so now before the price for the undertaking rises abnormally, as the prices for water and gas companies' rights have risen. Two remarkable instances will bring the lesson home. At Liverpool, Sir Frederick Bramwell has decided, on behalf of the Corporation, that a fair price for the company's rights and machinery would be four hundred thousand pounds. Now, the company has only spent some two hundred and fifty-two thousand pounds on the plant which will be handed over, and we are assured by Mr. Preece that even then the Liverpool Corporation will not be in any better position as regards output of generating plant than the Manchester Corporation, who have only spent one hundred and seventy-four thousand pounds. Again, at Newcastle-on-Tyne, the Corporation wish to buy back what in 1887 would have cost them next to nothing—*i.e.*, the right to supply their own ratepayers with electric light. The price there is yet to be fixed, but from Prof. Kennedy's report it will be gathered that this figure will have to be considerably higher than the capital outlay. The low price charged by the directors of the two enterprising companies in Newcastle has done much to increase the number of consumers, and with the present load they would be able to pay a very large dividend if their price was fixed at sixpence per unit instead of fourpence halfpenny to fourpence three-farthings. That they have already paid or could pay 5½ per cent. dividend while charging this price is a credit to their engineers. We consider that companies who, like those above mentioned, have exploited the work successfully with their own capital should receive fair prices for their stations. Another place where negotiations are going on is Taunton. Here the conditions are not similar to those in Liverpool and Newcastle, and remembering Mr. Kapp's report to the town in May, 1892, we do not suppose the price paid will be high. We still hold that the corporations or local authorities can undertake successfully the electric lighting of their districts,

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and do the work better than any company. At the same time we deprecate the attempts of certain syndicates to force the hands of the authorities in these matters for the sake of promotion money.

CITY GUILDS EXAMINATION.

As mentioned in our issue of May 10, we propose offering to the students who send us in the best set of answers to the recent papers, book prizes as follows:

For the best set of answers in the honours grade, any books on our list to the value of three guineas.

For the best set in the ordinary grade, books to the value of two guineas.

For the best set in the preliminary, books to the value of one guinea.

We leave it to the honour of the competitors that they do the work unaided, and that the answers are their own individual work. All answers must reach us here on or before Saturday, June 15. The successful students' answers will be published in this paper as soon as possible after that date, together with a *résumé* of the common points of error. Our list of books can be obtained on application.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

FIRE RULES.

SIR,—I was somewhat surprised at parts of Mr. Musgrave Heaphy's letter in your last issue, and wonder if he has the authority of the Phœnix Fire Office to damn, unread, the rules for electrical installations inside buildings about to be issued by the Institution of Electrical Engineers. He also seems to assume, on what ground it is impossible to see, that these same rules will cause fires, and that all insurance companies and electric light contractors must handle them with great care. While acknowledging the value of the rules prepared by Mr. Heaphy, I should value still more highly a set of rules prepared by such eminent engineers and electricians as have the matter in hand for the Institution. It would be most interesting if Mr. Heaphy as a prophet would state what the faults in the unissued rules will be.—Yours, etc., SALAMANDER.

DUBLIN TRAMWAYS.

SIR,—I have read your article on the report of Mr. Robert Hammond to the Dublin United Tramways Company with feelings of interest, amusement, and envy—interest in your views generally, amusement at your inconsistencies, and envy of your power of making statements which are unsupported by facts.

Your inconsistency is shown in your desire to make the local authorities discard their present fire-escapes for others which you consider more suitable, but which, so far as this country is concerned, remain untried on a large scale, and the fact that you wish the span-wire system to be adopted because it has been so successful in America; and the South Staffordshire system, although working with every success, is of recent introduction and something new. You go on to refer to the South Staffordshire system as a country line. This system runs through the main streets of Walsall, Wednesbury, and Darlaston. Walsall has a population of over 80,000, Wednesbury 25,000, and Darlaston about 16,000. The total length of lines is eight miles. The number of car miles run in 1893 was approximately 300,000, and the number of passengers carried 1,667,396. If this is your idea of a country line, your views as to a town line would be interesting.

You admit that the South Staffordshire system is an ingenious one, and suggest that the method was adopted because the track is near to the kerb. As a matter of fact, at no point is the line nearer to the footpath than 9ft. 6in., and in many places it is more than 26ft. from the footpath.

You apply "American" practices to English towns, where the conditions are altogether different. The "American" streets, as a rule, are broad and straight, and even under such conditions the overhead structure is not beautiful owing to the necessity of making the trolley wire follow exactly the curvature of the track. The route of the South Staffordshire electric line is a most tortuous one, the line is mostly a single line with turnouts, and if the wiring had been carried out on the "American" principle it would have been a most hideous sight, and would have formed a complete network overhead.

In reading your article, one would assume that if the difficulty of the passage of the fire-escapes down the streets was overcome by the introduction of horizontal ladders, that the great objection to the span wire would be removed. This, I think, shows your lack of knowledge of tramway working.

In America and on the Continent, speaking generally, such a thing as a tramcar carrying outside passengers is an unknown vehicle. In this country the most popular part of a tramcar is the top or outside seats, and great as may be the confidence, from an electrical point of view, of the public in an overhead system, I doubt whether they would ever reach that stage of confidence where they will place themselves directly under the trolley wire, with the liability of decapitation by the falling of a span wire.

I am sorry, Sir, that you have not yet realised that "if the mountain will not come to Mahomet, Mahomet must go to the mountain." My experience of the local authorities in this country is that they will not have the span-wire system. My knowledge of the travelling public upon tramways is that they will insist upon having outside seats, without awning over the top, and they will not expose themselves to the danger of riding under a wire when it can be avoided. My certain knowledge of the working of various overhead span-wire systems is that your statement that the span-wire system, in certainty and economy of service, is better than the South Staffordshire system, is an entirely erroneous system.

Your suggestion, that the best method of supporting the trolley wire for the tramway track in broad streets is the centre pole, may be a correct one when you start *de novo* with a tramway, and can so arrange the spaces between the tracks as to remove any cause of danger to passengers riding on the cars by striking the poles, but their adoption on lines already laid in this country would be a very great mistake, and would, in my opinion, lead to many serious and fatal accidents.—Yours, etc., JAMES L. OWEN.

120, Colmore-row, Birmingham, May 18, 1895.

WHAT, WHEN, AND WHERE.

Society of Arts, John-street, Adelphi, Strand.

May 27, 8 p.m.—Cantor lecture. "Japanese Art Industries," by Dr. Ernest Hart. Lecture II.

May 28, 8 p.m.—Applied Art Section. "The Decoration of St. Paul's," by Prof. W. B. Richmond, A.R.A.

Royal Institution, Albemarle-street, Piccadilly, W.

May 25, 3 p.m.—"Picture-Making," by Seymour Lucas.

May 28, 3 p.m.—Thirty Years' Progress in Biological Science," by Prof. E. Ray Lankester.

May 30, 3 p.m.—"Spectroscopic Astronomy," by Dr. W. Huggins.

May 31, 9 p.m.—"The Radiant Heat from the Moon during the Progress of an Eclipse," by the Earl of Rosse.

Institution of Civil Engineers.

May 28, 8 p.m.—In the Theatre of the Royal United Service Institution, Whitehall, the annual general meeting of the institution, to receive the report and elect the council and auditor for the ensuing year.

Northern Society of Electrical Engineers.

May 27, 7.30 p.m.—At the Palatine Hotel, Hunt's Bank, Manchester, council meeting; 8 p.m., ordinary general meeting, "The Uses of Accumulators," by J. C. Howell. Adjourned discussion.

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CITY AND GUILDS OF LONDON INSTITUTE TECHNOLOGICAL EXAMINATIONS, 1895.

ELECTRIC LIGHTING AND POWER DISTRIBUTION.

ORDINARY GRADE.

Instructions.

The candidate must confine himself to one grade only, the ordinary or honours, and must state at the top of his paper of answers the grade he has selected. He must *not* answer questions in more than one grade.

If he has already passed in this subject in the first class of the ordinary grade, he must select his questions from those of the honours grade.

In the honours grade the student may, during the examination, use an electrical engineering pocket-book, but if he avails himself of this he must state the title of the book on his answer paper, and in his answers give references to the pages of the book he has consulted.

The number of the question must be placed before the answer in the worked paper. Three hours allowed for this paper. The number of marks obtainable is the same for each question. (Not more than *eight* of the following questions to be answered.)

1. Describe and give a full-size hand-sketch of one of the modern kinds of electrostatic voltmeters.
2. What is the use of the series coil in arc lamps run in series with an unvarying current?
3. Sketch a drum armature showing the connections and windings for 24 conductors on the outside. Sketch also any methods of end connection for drum machines in ordinary use.
4. What are the advantages and disadvantages of running incandescent lamps at high efficiency?
5. Draw a solenoid showing roughly the lines of force before and after the introduction of a soft iron core.
6. How does slipping a copper tube over the core lessen the spark of an induction coil?
7. How would you wind a medium-sized motor (say 10 h.p.) to run at constant speed with varying load? And how would you start such a motor?
8. What are foot-pound, poundal, dyne, and kilogram-metre? And how are they related?
9. If 10,000 kilocoulombs are passed through cells arranged in series containing solutions of Cu_2Cl_2, $Hg_2(NO_3)_2$, $CuSO_4$, H_2SO_4, and NaCl, how much copper, mercury, hydrogen, and caustic can be obtained?
10. What are the advantages and disadvantages of the Planté and pasted plates for secondary cells?
11. What are the advantages of separate field magnets for the two armatures in continuous-current transformers?
12. A series dynamo has an armature resistance of 0·4 ohm, and a field resistance of 0·6, and gives 120 terminal volts at a given speed and current of 10 amperes: work out its electrical efficiency as a dynamo and as motor at that speed and current.
13. Describe one kind of alternate-current motor.
14. When are alternate-current systems better than continuous-current systems? Give your reasons as fully as possible.
15. What peculiarities are there in the design of a dynamo for supplying arc lamps in series at (say) 3,000 volts?
16. Give a rough scheme of a switchboard for a station with batteries and feeders and a three-wire system.
17. What is your idea of the advisability of earthing the secondary in transformer systems?
18. What is the construction of an ohmmeter?
19. Why does an electromagnet spark on breaking the exciting circuit?
20. How are the pull and self-induction of an electromagnet connected?
21. A condenser having a capacity of two microfarads is connected to two terminals maintained at 2,000 volts; how much work is taken from the terminals, and how much can be got out of the condenser again?
22. What magnetic quantities are denoted by the symbols H, B, and μ; and how are they related to one another?
23. Given a ring armature 10in. long, 10in. diameter, 1in. radial thickness of iron, what wire would you use to give 110 volts, and what current would be suitable? Speed, 1,000 revolutions per minute.

HONOURS GRADE.

Candidates for honours must have passed in the ordinary grade. They may select their questions from one only of the following sections:

Section I.—Electrical Instruments, etc.

Answer questions Nos. 1 and 16 of the ordinary grade, together with not more than *five* of the following:

24. Compare the merits of the suspended coil (or Deprez) and the needle (or Thomson) galvanometer.
25. What metals or alloys are best for resistance coils, and what for the coils of voltmeters? Give reasons.
26. Describe Heaviside's, Thomson's, or any other good method of measuring very low resistances.
27. How would you test or check a differential galvanometer?
28. How would you calibrate a ballistic galvanometer, a known E.M.F. being given?
29. What is the potentiometer method of measuring (*a*) pressures and (*b*) currents?
30. What errors would you look out for if you were given a voltmeter to report upon?
31. How would you make a wattmeter for alternate-current work?
32. What are the relative merits of (*a*) hot-wire, (*b*) electrostatic, and (*c*) solenoid and core voltmeters for 100 and for 2,000 volts, alternating and continuous?
33. Describe critically any form of alternate-current supply meter with which you are acquainted.
34. Sketch a set of apparatus and connections suitable for the calibration of commercial instruments.
35. What is a dial bridge, and how are its coils connected?

Section II.—Dynamos, Motors, etc.

Answer questions Nos. 3 and 12 of the ordinary grade, together with not more than *five* of the following:

36. Design a transformer to give 50 amperes at 100 volts on a 2,000-volt circuit, 100 periods per second being taken as the frequency.
37. Give a hand-sketch of a tramway motor. What is the rated power of the motors generally used in tramway work?
38. What are the advantages, or the reverse, of single-limb magnets in small and large drum and ring machines.
39. Why is it more difficult to insulate a drum than a ring armature?
40. Draw a curve showing relation between a magnetic flux and the excitation in an ordinary low-voltage dynamo; and state what excitations would be suitable for a shunt, a compound, and a battery-charging machine.
41. Describe any safety devices for transformer circuits that you know of, and say how far you think they are really useful.
42. What are the merits and drawbacks of "hole" wound armatures?
43. Give your idea of the difficulties encountered in the design and construction of a good alternate-current motor.
44. Explain the action of a double-circuit, or two-phase (as it is sometimes called), motor.
45. What are the respective merits of steel, wrought iron, and cast iron for dynamo field magnets?
46. Why is the drop of a transformer greater when the secondary has self-induction in circuit?
47. Should a choking coil have an open or a closed iron circuit? Give your reasons.
48. Describe the best methods of testing large machines with small driving power available.

Section III.—Lighting and Power.

Answer questions Nos. 14 and 16 of the ordinary grade, together with not more than *five* of the following:

49. Given an engine and dynamo, how would you test the combination as regards steam consumption and output?
50. What are the advantages and drawbacks of parallel running in high-pressure alternating systems?
51. Why are arc lamps run off 110-volt circuits with resistances in series with each pair, instead of off lower pressures without the resistances?

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52. What are feeders? Give a sketch of the switching arrangements in a transformer sub-station where there are several 50-kilowatt transformers and a three-wire secondary system.

53. Give your idea of the chemical action in an accumulator.

54. Describe one or two systems of street mains for low-pressure and high-pressure distribution.

55. Describe critically a continuous and an alternating current meter.

56. How does the probable load diagram influence the choice of a system for a given town?

57. Describe the kind of transformer used in a system for distributing two-phase currents.

58. In what way is the potential drop in mains affected, in alternate-current work, by (*a*) the frequency adopted for the currents, (*b*) the proportion of motors in use, (*c*) the design of the transformers used?

THE THEORY OF ALTERNATING CURRENTS.—IV.

BY A INST.E.E.

§ 11. **Definitions.**—As already intimated, we shall frequently find it necessary to make use of the sine curve (§ 9) in representing graphically alternating E.M.F.'s and alternating currents. In fact, such representations are so important that we shall now define certain geometrical terms associated primarily with harmonic motion, but which now are everyday expressions in alternating-current literature. At this stage we shall restrict ourselves to the terms intimately connected with sine curves, and introduce the few remaining terms when we require to use them.

Periodic Changes.—A set of operations which are repeated in exactly the same manner, in successive and equal intervals of time. Both alternating E.M.F.'s and currents are periodic changes, and we shall treat them as periodic E.M.F.'s and periodic currents which have the sine law.

Sine Curve.—A curve such that the successive values of consecutive points on the curve with respect to time, vary as the sine of an angle proportional to the time. Fig. 7 depicts the curve for an alternating E.M.F. induced by a simple loop, rotating in a uniform magnetic field, as considered in § 7, and, as already explained, P p measures the E.M.F. induced at the instant denoted by p. In other words, P $p = E_\theta$, and $E_\theta = D \sin \theta$, which is the equation to a sine curve. $x\,x'$ is the time line on which intervals of time are marked. θ is the phase as defined below.

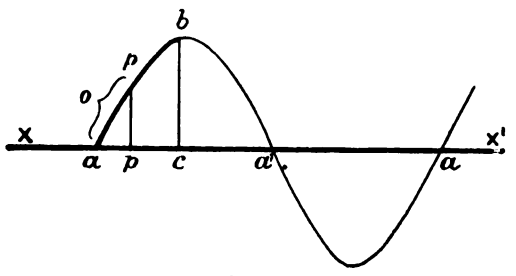

Fig. 7

Alternations.—The changes in the direction of an alternating E.M.F. or current. The part of the curve $a\,b\,a'$ represents an alternation in the positive direction.

Cycle.—A complete set of changes produced during one revolution of the loop. Each cycle consists of two alternations, and is represented by the curve $a\,b\,a'\,b'$.

Periodic Time or Period.—The time taken to complete one cycle. The length $a\,a'\,a$ on the line $x\,x$ denotes a period.

Frequency or Periodicity.—The number of cycles completed in a second; in other words, it is the reciprocal of the period, and is symbolised by the letter f, or the symbol $\sim\!\sim$. If the periodic time is T, then $\sim\!\sim = \frac{1}{T}$. If p = number of pairs of poles, and n = revolutions per minute, then $\sim\!\sim = p\,n/60$. In practice, the number of complete cycles varies from 25 to 130.

Amplitude. — The maximum perpendicular distance between the zero line and the curve $b\,c$ is the amplitude of the curve in Fig. 7.

Phase.—The fraction of a period which has elapsed since the rotating loop (armature) was in the position of zero E.M.F. in the positive direction. Both θ and $a\,p$ denote the phase of the point P, since $a\,p$ is the same fraction of the period, $a\,a'\,a$, that the angle θ is of four right angles.

§ 12. **Mean or Average Values.** — In the E.M.F. curve (Fig. 7) the maximum value is indicated by the length of $b\,c$, but since an alternating current varies in strength from instant to instant, and has values varying from zero to its maximum, it is evident that $b\,c$, the maximum value, is not the measure of the effective pressure sending the current through the circuit. We thus require other expressions, the most important of which is one that corresponds with an unvarying E.M.F. sending a steady current, which produces the same heating or dynamical effects whilst traversing a conductor without self-induction and capacity, as an alternating current produces in the same interval of time, whilst passing through the same conductor. In what follows, the maximum instantaneous values of E.M.F.'s and currents will be denoted by E_{max} and C_{max} respectively; and any other instantaneous values will be denoted by E_θ and C_θ, θ being the phase or the position of the revolving coil.

And since the quantity of electricity passing along a conductor, as well as the work done by the current, is not proportional to the maximum value of the E.M.F., we must now distinguish between three different values:

(1) The maximum instantaneous value;
(2) The mean value, or average;
(3) The effect value;

in terms of which the magnitude of alternating E.M.F.'s and currents may be stated: and, further, since these values bear fixed ratios to each other, it is necessary to determine and state what the relationships are which exist between them, and here it will be well to point out that whatever is true respecting the various relationships of the above values of alternating E.M.F.'s will be true for similar relationships between the resulting alternating currents so long as they obey the sine law, which we shall assume to be the case throughout these articles. Bearing the above statement in mind, we shall determine the ratios between the above three values of alternating currents.

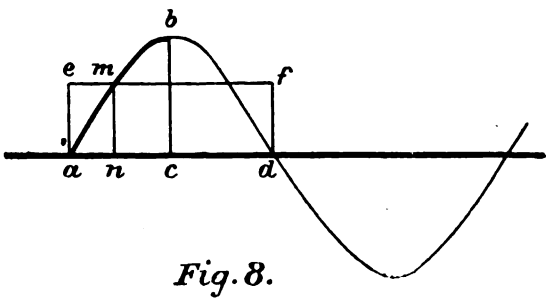

Fig. 8.

An alternating current obeying the sine law is represented graphically by the curve in Fig. 8, and, as before, the value of any point on the curve is given by the equation $C_\theta = C_{max} \times \sin \theta$. The maximum value has already been considered, so that we now shall pass on to consider the mean or average value. It is clear that if we divide a period into a large number of very small and equal parts that we shall get a series of increasing values for the current strength corresponding with every division, and if we erect at each division an ordinate, the lengths of the ordinate, and hence the value of the current, will be given by the equation $C_\theta = C_{max} \times \sin \theta$, in which θ is the phase corresponding with the individual divisions. The arithmetical mean or average value of such a series can be proved to be $2/\pi \times C_{max}$. This is shown by the length of the ordinate, $m\,n$, or the height of the rectangle, $a\,e\,f\,d$, in Fig. 8; and it may be mentioned here that the area of the rectangle, $a\,e\,f\,d$, is equal to the area enclosed by curve $a\,b\,d$ and the base line, $a\,c\,d$. Since $2/\pi = \cdot 6369$, or $\cdot 637$, $\cdot 637 \times C_{max}$ is the value of the equivalent continuous current which conveys the same quantity of electricity through a circuit without induction as an alternating

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current, the maximum value of which is C_{max}, does in the same period of time. This value we shall call the *true mean value*. Similarly, the true mean value of an alternating E.M.F. is ·637 E_{max}. In future, E_m and C_m will denote the true mean value of an alternating E.M.F. and current respectively.

§ 13. **The Effective or Virtual Value.**—The true mean value just found, however, is not of much practical importance, since the light produced in an incandescent lamp, the heat produced in a wire, and the work done by a current is proportional to the square of the current passing. And, further, it is necessary to use instruments depending on the heating effects or electro-dynamic attractions and repulsions to measure alternating E.M.F.'s and currents, and these depend upon the square of the current. Thus the Cardew voltmeter is used to measure alternating E.M.F.'s, and, as is well known, the number of units of heat, H, generated by a current of C amperes in a time t is given by the equation $H = C^2 R t \times ·24$. Now, to obtain the value of an alternating current which is equivalent to a continuous current producing the same amount of heat, we must determine the mean of the squares of the current given by the ordinates for each division mentioned above, and the mean of the series of squares given by the equation $(C_\theta)^2 = (C_{max} \sin \theta)^2$, the phase, θ, varying between 0deg. and 90deg., can be proved to be $\frac{1}{2} . C_{max}^2$ or $·5\ C_{max}^2$. This is the effective value, or, as it is generally termed, the virtual value, which we shall denote by C_v, so that $C_v^2 = ·5\ C_{max}^2$, or $C_v = C_{max} \times \sqrt{·5} = ·707\ C_{max}$. The virtual value of a quantity, current or E.M.F., obeying the sine law is the square root of the mean of the squares of the instantaneous values. For the sake of brevity, this long expression is usually written $\sqrt{\text{mean square}}$. Since

$C_v = ·707\ C_{max}$, we get $C_{max} = C_v / ·707 = 1·414\ C_v$, from which it is clear that an alternating current, the maximum instantaneous value of which is C_{max}, generates H units of heat in the wire of a Cardew voltmeter, and by noting that H units of heat are generated by a continuous current of C amperes, we get the following definition:

An alternating current of one ampere is such that the heat developed by it in passing through a non-inductive resistance is the same as would be developed by a continuous current of one ampere strength passing through the same resistance in the same time.

Similarly the virtual volts, $E_v^2 = \frac{1}{2} E_{max}^2$ and $E_v = ·707\ E_{max}$, from which we see that the alternating pressure which produces light in an incandescent lamp, or readings of a Cardew voltmeter, is ·707 of the maximum pressure. In other words, the light, or deflections produced, indicates a pressure equal to 70·75 per cent. of the maximum pressure. The following example of an alternator will help to make the matter clear: A Mordey alternator (75-kilowatt size) supplies 37·5 amperes at 2,000 volts to a certain circuit. The frequency is 100. The maximum E.M.F. generated is 2,000 × 1·414 or 2,828 volts, so that the E.M.F. generated by this machine changes from 2,828 positive maximum volts to 2,828 negative maximum volts 100 times per second. In other words, 2,828 is the value at the peak of the wave, and 2,000 the virtual or effective voltage.

The relation between the two mean values thus found is as follows:

$$\frac{\text{The virtual values}}{\text{The true mean values}} = \frac{·707\ E_{max}}{·637\ E_{max}} = 1·1, \text{ or } E_v = 1·1\ E_m,$$

that is, the virtual value is 10 per cent. greater than the true mean value. In practice, we have only to deal with virtual volts and virtual amperes, but it must not be forgotten in designing alternators, specifying conductors, and constructing measuring instruments, that in all cases the insulation must be such that it will stand a pressure equal to the maximum instantaneous value.

Let us now consider one or two numerical examples.

(1) A cable for continuous currents was insulated for 500 volts. What is the highest virtual pressure of an alternating current for which this cable is suitable?

Since $E_v = ·707\ E_{max}$,

and $E_{max} = 500 . \therefore E_v = ·707 \times 500 = 353·5$ virtual volts.

(2) A Siemens dynamometer indicated that a current of 30 virtual amperes was passing through a circuit. What quantity of electricity was passing per second?

Since $C_v = 1·1\ C_m . \therefore C_m = ·9\ C_v$,

and $C_v = 30 . \therefore C_m = ·9 \times 30 = 27$ amperes per second.

(To be continued.)

OPPORTUNITIES IN ELECTRICAL ENGINEERING.*

BY A. A. ATKINSON.

Papers have frequently been published in the electrical journals deprecating the over-popularity of the electrical business in its various phases, claiming that the profession is already overcrowded, and upon this ground offering discouragement, sometimes in very strong terms, to the aspiring engineer.

It is only fair, of course, that an attempt be made to present the other side of the question. To this end this paper is written. For I cannot help seeing much encouragement in the outlook. Everything considered, I find electrical engineering in the broad acceptation of the words, if not on a flattering, at least on a very favourable basis as compared with other professions in regard to attractiveness, educational value, and money return. In this it will be apparent that I am not at all Malthusiastic. I believe there is room and to spare.

Why should young men be discouraged from preparing themselves in a business and an electrical way to take charge of lighting stations and power plants, or any other practical applications, "because the growth of this business is not likely to be either sudden or rapid, or the opportunities offered particularly brilliant"? Should we say to the young man that has the aptitude and inclination for something else, "stay on the farm, or in the shop, or in the store at 25dol. or 30dol. a month, because if you go into the electrical business, for instance, you cannot get more than 40dol. to 60dol. a month"?

Is it any more of an argument for the opposition to state that "the electrical railways at present do not seem to appreciate the need of trained men, and most of them are satisfied with their horse railway superintendents who have picked up enough of electrical information to make the cars run whether a dividend is paid or money sunk"? The statement refutes itself, for it certifies to the very conditions that do demand the right kind of men. Let the men proper prepare themselves and prove their necessity to owners of electrical stock. The only reason that such a condition exists is on account of the paucity of the men who are able by training to bring the business out of its present status. These and similar positions are not open to the merely technical and high-priced theorists. They belong to those who have been advised in the course of their instruction of the exact conditions and practically prepared for what is, not taught to expect big salaries and find or make positions to suit them. One of the things I also believe that often cast discredit upon the value of a college preparation is the lamentable failures of some technical graduates in attempting to manage practical electrical matters. And these conditions are not at all fanciful. Just such bad management is very easy to find in lighting and in power transmission in all too many places. Just these conditions are the argument for better men trained for the right thing.

I grant that there are too many who enter the profession with the purpose of "making their mark'—just the kind that are most apt to meet with failure. But as much can be said of any profession under the sun. I believe, also, that as the term "electrician" ought to be understood—not the electric bell and annunciator fiend—but few are needed. I grant again, that many applications are being refused by manufacturing firms—they themselves even failing and going out of business. Granted that many classical graduates enter engineering schools to swell the ranks of that profession. All this admitted, I still contend that there are abundant opportunities for the pushing men who understand their business. Leaving out of consideration for the

* From *Electricity*, New York.

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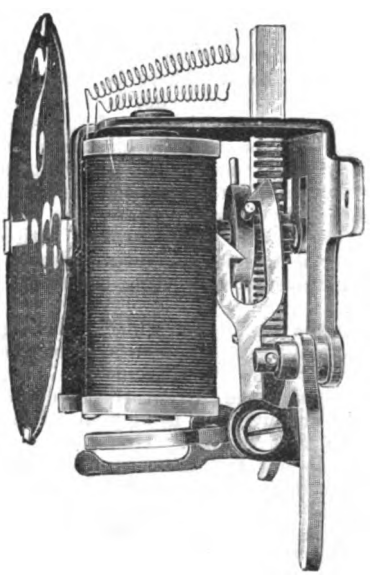
present the character of the positions offered in the various lines of professional and practical work, and looking only at the numbers studying for engineering in one or two instances, I know personally that in one or two institutions whose catalogues were quoted by Mr. Floy to show the great number of students of engineering, at least six to eight times as many are at the same time registered in the law departments alone, to say nothing of the medical and other professional departments, aside from the single professional schools in cities everywhere. Even if we should admit that only one-eighth as many men are required in the varied lines of electrical work as in the legal pursuits, still we are on favourable ground, with not the least reason to deprecate the number.

The value of the electrical engineer, and hence his success in the business undertaken, will depend on three things—namely, natural ability and aptitude of the individual, the character of his course of training, and the general view of the situation with which he leaves college. And this will lead us to consider the relative advantages of a purely technical and a practical education. Of course, the third condition of success may result from either of these. But before undertaking either course the individual must satisfy himself by a study of his proclivities, so to speak, whether he has any ability and inclination in the direction of electrical engineering. He need not enter the profession for money or fame if he does not like to work out the course, practice, and theory, almost as well as to eat. Certainly, if he study only for the mental discipline and for a personal knowledge of the subject, this would not be true to the same extent. Or if his desires run toward business, law, medicine, sport, or idleness, he will not succeed as an electrical engineer. But supposing that we have to deal with those only who should properly be engineers, so far as opportunities in life suggest, what kind of course shall be selected?

(To be continued.)

NEW INDICATOR MOVEMENT.

A new indicator movement, an illustration of which we give herewith, has been brought out by the International Electric Company, of 55, Redcross-street, E.C. They call it the triplex movement, and it allows of three different signals being given with the same movement.



It is constructed on the principle of their "Universal" bell, described in the *Electrical Engineer* of July 27 last. While hitherto a prearranged code of signals has allowed of making use of the same bell to give different signals and to call different people, the want of a recording instrument that would show correctly the number of calls has been felt.

The "Triplex" movement records permanently (until replaced) who has been called, so that when the bell has been rung once, twice, or three times, each different signal attached to the same movement will appear consecutively and remain visible. Indicators fitted with this movement could with advantage be used on board ship in the ordinary way, as the "Triplex" has a locking arrangement, which only drops when a current is passed, and is not in any way affected by the rolling of the ship, even in the severest weather.

ALTERNATING AND INTERRUPTED ELECTRIC CURRENTS.*

BY PROF. GEORGE FORBES, M.A., F.R.S., M.I.C.E.

LECTURE III.

Sometimes at the close of a lecture the lecturer finds that he has miscalculated his time, and has to hurry through things more rapidly than he intended, so I shall begin by saying a few words which I should have said at the end of the previous lecture but for the reason just stated. In the course of these lectures I have been able to show you some interesting experiments in different branches of electricity, and also certain curious phenomena connected with them. I wish, in the first place, to say that in all these experiments there is nothing original or new—that they are simply illustrating well-known principles; and, secondly, that I have to express my great indebtedness to all those who have assisted me in the matter—and especially I feel that I owe a great deal to Mr. Campbell Swinton, who has put at my disposal this induction coil and much of the apparatus which you see before you, some of which I shall be using to-day. I wish, also, to express my indebtedness to Dr. Alexander Muirhead for the use of the different illustrations in the matter of the submarine cable, and also to my assistant (Mr. Mitchell), Mr. Stanton, and Mr. Edgar, who have made the work of preparing these lectures quite contrary to what it usually is—a pleasure instead of a labour.

If in any of the illustrations that I have given you of the analogies between electrical phenomena and mechanical phenomena I have introduced anything different from what you have been accustomed to, it is simply a natural interpretation of the mathematical formulæ that represent the phenomena. Mathematics applies equally well to mechanical phenomena and to electrical phenomena, and it seemed to me a suitable thing not to use mathematics to illustrate electrical phenomena, but to use mechanical phenomena to illustrate the electrical.

Now about these analogies which I have used. I wish to impress upon you before we part that there is more in these analogies than the mere rough resemblance which I have tried to point out to you in the course of these lectures. and those who are more deeply interested in the applications of electricity will easily see that there is room for a great deal of thought in carrying out these analogies, and making clearer in their minds the processes which are going on in certain electrical phenomena.

In the table which I showed you last lecture I gave you an example of the methods of measuring the actual units when we are using the torsion of any rod or other mass to represent electric currents, and I wish to say that if in the case of any electrical problem occurring to an engineer—such, for example, as the propagation of electricity along a cable from Niagara Falls to Buffalo—if he wishes to see whether troubles will arise in the electrical phenomena, if he will make an imitation cable on the lines of assuming those units which are in the table, he will be able to imitate the action of what goes on in the real cable, and he will be able to see whether any peculiar mechanical effects are produced, and to trace their analogy with the electrical effects, and so be able to see what kind of troubles he is likely to meet with. And this I consider to be a matter of very great importance, and it was with the object more of throwing out suggestions than of working out the analogies in a complete form that I introduced them in the present course of lectures. The working of them out in a complete form would not have been a suitable subject for these lectures, but I hope I may have time on another occasion to work some of these analogies out more fully, and so to render some assistance to those who are engaged in such work.

In the first lecture I was dealing chiefly with capacity and the influence which it has upon alternating or interrupted currents, and the most interesting illustrations of the effects of capacity were naturally found in the submarine cable. Last lecture I was dealing chiefly with self-induction, and I showed you that there were certain troubles which were likely to arise in any case in which we used self-induction, and I explained to you that this would be the case with other kinds of currents, whether we are using continuous currents or alternating currents; that in either case if you have much self-induction in the circuit, by breaking the circuit you are able to get far larger E.M.F.'s than what you are impressing upon the system, and these may be destructive to the insulation of the system. The only difference is that in the case of alternating currents, the self-inductions that we have in the transformers are enormously greater than those when using a continuous current; and, therefore, the importance of this question becomes clearly greater in the practical application of alternating currents, and especially in the practical application of them on

* Lecture delivered before the Royal Institution.

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a gigantic scale as in the case of the utilisation of the Niagara Falls, where the transformers are of enormous magnitude and the self-induction very great indeed. In such a case as that it would be, I might almost say, criminal to suddenly break the circuit, the danger would be so great.

Now, to-day, passing from these two subjects, I am going to deal with three other peculiarities which arise in the transmission of electric currents, especially alternating or interrupted currents—skin resistance, resonance, and oscillations. All of these are interesting phenomena from a purely scientific point of view, and are of far more importance from an engineering point of view. I mentioned in the course of the last lecture that a great many of these difficulties in the engineering problem can be got over by reducing the frequency of the alternations. When I first reported to the people who are utilising the Niagara Falls in the year 1890, now some five years ago, as to the proper means of utilising them, I urged the adoption of the system we are now introducing; and on noticing those various troubles that might arise I gave the best solutions of them that seemed available. Since that date the enormously valuable suggestion occurred to me of the lowering of the frequency of the alternations, and that, together with the other precautions that have been introduced, has taken away all the danger of any trouble that we might otherwise have expected from the use of alternating currents with such a system.

When we come to very high frequencies, these effects are greatly increased; and by means of Mr. Campbell Swinton's apparatus which I have been employing I have been able to get very high frequencies indeed. By using an oscillatory discharge (about which I shall speak more fully later on) which oscillates at very rapid frequencies, and also by using high E.M.F. in this discharge, I am able to get effects which could not be got by an ordinary alternating current. At the same time, by observing the effects with these very high frequencies we are able to grasp what is going on at the lower frequencies, though not to such a serious extent.

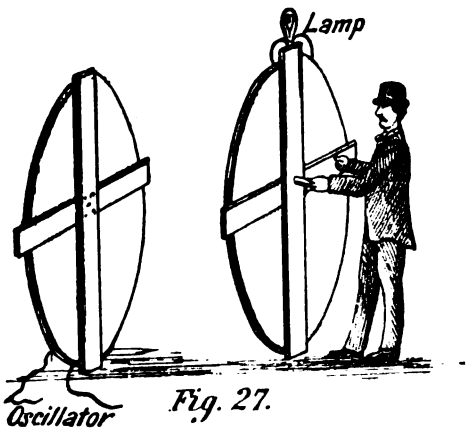

Fig. 27.

I will now show you the effects of mutual induction between two circuits which can be obtained by means of very high frequencies and by very high electrical pressure—great voltage. I am going to employ the two copper wire hoops (Fig. 27), measuring about 6½ft. or 7ft. in diameter, which are standing in front of me, and I am going to pass through one of them an oscillatory discharge of very high frequency indeed and of very high electrical pressure. Now, everyone who is accustomed to seeing cases of mutual induction will be perfectly well aware that if we are simply passing an alternating current through one of these wires, it would be impossible to induce much force in the other wire. I wish to show what a considerable amount of power can be developed when the E.M.F. is sufficiently high and the frequency sufficiently great. And that is what we are doing when we use the oscillatory discharge of Mr. Campbell Swinton. I take away from the apparatus one of the hoops, to which I have attached an incandescent lamp at the top. I will immediately cause a high-frequency oscillatory discharge to pass round the other, and I wish to show you that even at a considerable distance the current which passes through the wire which I am holding is sufficient to light the incandescent lamp at the top. [*Experiment.*] At the present moment the illumination is not visible. I approach the hoop nearer to the coil. At this distance it is very dull indeed, but still perceptible. I now approach to within a couple of feet, and you see it rises to its full brilliancy. That is simply due to the induced current which is going round this wire of a diameter of 7ft. I can twist it round in different directions, almost at right angles to the fixed one, and still get a certain amount of illumination, but when it is completely at right angles it goes out. When I turn round again and the two wires are once more parallel, the brightness is as great as it was before.

Now, I intend to take some of the same apparatus which I have been using here to show you another very remarkable effect of these high-voltage experiments. When we use very high electric pressures we require a much smaller current to produce the energy which lights up an electric lamp, for instance; and if we send very high electric pressures through a lamp with intervals of rest, when the current is not passing, we are able to produce a very large current for a small fraction of time, after an interval another very large current, and on the whole the total quantity of electricity which has passed through to produce the lighting of the lamp will not be so great as the total quantity which would have passed through if we had had an ordinary continuous or alternating current passing through the lamp. The effect which takes place on the lamp is measured by the square of the current. Let us take two cases—first, of a lamp and the current continuously going through it; we have a certain amount of electricity passing through the lamp; in the second case, if we pass it for one-tenth of a second each second of time and pass 10 times as much current through it we would get 100 times as much effect during that tenth of a second: therefore, you would get 10 times as much effect on the whole It follows, then, that when we increase the maximum current during a short period we are increasing the energy which is supplied to the lamp during that period far more than we are increasing the current. It appears, therefore, that by acting in this way we are able to pass a far smaller sum total of current through the lamp and yet to get the same amount of energy consumed in the lamp. This is probably the reason why an electric lamp can be lighted through a person's own body, as is possible with such apparatus as is before you. The amount of current which I am able to stand without injury from hand to hand is certainly less than 1-100th of an ampere; and if I can show that a lamp can be lighted through my body, I know that there is not in the energy more than 1-100th of an ampere passing through the lamp, and yet if I bring the lamp up to incandescence—a lamp that ought to require one-fifth of an ampere—I must assume that the energy is the same, but that the total quantity of electricity is not the same; and that is what I wish to show you is the case in the experiment. Now, this is an experiment which everybody does not like to try, so I will ask Mr. Campbell Swinton, who has

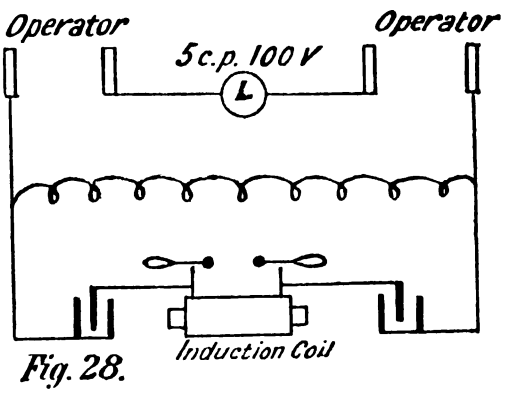

Fig. 28.

arranged the experiments, if he will assist me in taking the current through the body. There is really not the slightest trouble, or danger, or inconvenience in doing it. I showed you in the first lecture some experiments of the same sort. There it was perfectly obvious that the electricity was not passing through the body which was lighting the lamp, but in this case it is perfectly obvious that the electricity is passing through the body (Fig. 28). [*Experiment.*] Now, the electricity coming from that coil is certainly going through both of our bodies, and we can lower it to any amount we please, or raise it up to its full incandescence, by cutting out more or less of the impedance coil.

Now, whether the explanation which I have given you, and which Mr. Campbell Swinton supports, is the complete explanation or not I cannot tell you. It seems to go a long way towards explaining it. Passing the current through the body is a very different thing to receiving it, using yourself as a Leyden jar, as I did in the first lecture. There, there is no sensation whatever; you do not feel the current at all. In this case both Mr. Campbell Swinton and I felt the current passing through our bodies—and it was nearly as much as one cared to take comfortably, and one feels a certain amount of warmth, but I do not think that that is the true calorific value which is imparted owing to the energy used up in one's body; but it certainly does warm one.

I now wish to introduce to your notice a subject which has attracted considerable attention during the last eight or nine years in the use of alternating or interrupted currents. I speak of what has gone by the name of "skin resistance." The fact has certainly been proved—and it could not be otherwise, from the mathematical treatment of the question—that when we pass a high-frequency alternating current through a conductor the flow of current is not uniform throughout the section of the conductor. It is, partially at least, confined to the exterior layers of the conductor. At the centre there is not so much

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current passing as there is through an equal section of the outside, and therefore the resistance of the conductor is composed more of the resistance of the external parts than of the central part, because if we make the frequency high enough we can cause the current to cease flowing from the central part entirely. In that case, the material which is offering resistance is simply a tubular conductor and not a solid conductor. That is the meaning in which the term "skin resistance" must be read.

It was, I think, in the presidential address to the Institution of Electrical Engineers in, I believe, the year 1885, that Prof. Hughes first introduced this seriously to the notice of electricians. I do not mean to say that some of the effects had not been observed before, and I do not say that it was not known that there might be difference of flow in different parts of the section of the conductor, but that was the first date when this resistance was proved to consist of a pure definite resistance, and was measured in ohms as a resistance by Prof. Hughes. Up to that time people had been perfectly well aware that, in using the methods of the Wheatstone bridge, if you kept the key of the galvanometer, a deflection of which indicates divergence from the resistance, down, and interrupted the circuit, you could not get a true reading. Generally, this was ascribed to self-induction, which at the time of breaking the circuit with the electric battery made itself apparent, but which to a far greater extent, except when you are using coils, was often due to what Prof. Hughes showed to be really an increase of the resistance, and that increased resistance is due to the electric current being at the outside instead of being uniformly distributed through the section of the conductor which was carrying the current. Now, the explanation of this is not difficult to seek. You remember in the last lecture I had two wires of about 7ft. long parallel to each other. I passed an electric current through one, and at the moment of making that circuit the other whose circuit was completed through the galvanometer showed an induced electric current, and at the moment of breaking the primary current the circuit connected with the galvanometer showed an induced current, but in the opposite direction to that previously exhibited. Thus,

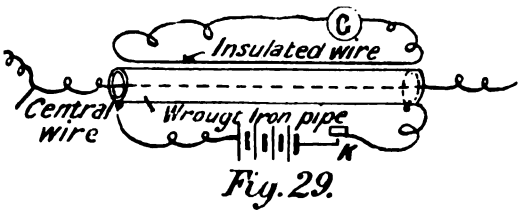

Fig. 29.

in an interrupted current, at the moment when a change in the direction of the electric current takes place, there is a reverse effect due to mutual induction. Now, suppose that this rod on the table (which is merely for illustration) consisted of a bundle of wires, and I insulated and separated out the central wire, and also insulated and separated out one of the external wires, and then sent through the whole bundle an electric current, there will be an induction current in either of those which I have selected and insulated; there will be in those an opposing E.M.F., a force tending in the opposite direction to that in which the primary current is going. But if you will notice the position of all the wires in the bundle relatively to one of them on the outside, and also notice the position of them relatively to the central wire, you will see that the central one has far more wires within a short radius of it than the external one has. Therefore the opposing force on the central wire is much greater than the opposing force on the external one, so that, when I suddenly pass an alternating current through a bundle of wires, at each change in the direction of the current there is an opposing force in both these wires, but the opposing force in the central wire will be much greater than that in the outside wire. That is to say, there is an opposing force in each of the wires of the bundle, but a greater opposing force in the central part, and therefore the current will not flow so powerfully there as it does at the outside. If, therefore, we have the whole bundle grouped into a solid conductor, the central line has always an opposing E.M.F. which is greater than the opposing E.M.F. at any other portion of the section. Therefore the current is mainly passing through the external part of the conductor, and that causes an increase of resistance, which was actually measured by Prof. Hughes by means of the ingenious apparatus he produced on the occasion to which I have referred.

Now, here is a brass tube with which, however, it would take some time to show you the effect, because it needs a very sensitive galvanometer, and it takes some time to bring it to rest. Prof. Hughes showed that the additional resistance produced by an iron conductor was much higher than a conductor made of any other material. Therefore, I will proceed by utilising an iron tubular conductor (Fig. 29) with a wire suspended through its centre and another insulated wire lying on its surface, and I wish to show you the different effects of induction in these two cases. I will begin with the outside wire, which is subjected to the induction at varying distances up to the diameter of the tube. There will only be a deflection in this case of two or three divisions of the scale on the screen, so you will please watch carefully and make the measurements for yourselves. [*Experiment.*] There, you see, it goes nearly up to the two divisions. I passed the current through this mass of iron, and the induced current on the outside parts of the wire was sufficient to deflect it through about one and a half divisions of the scale. Now change the connections, and you will see the great difference there is. [*Experiment.*] This time you see that the deflection passed along nearly the whole length of the scale. That is the deflection obtained with the wire which passes through the centre of the tube, showing the enormous difference of the E.M.F. in the two parts. This enormous effect in the case of the iron is due to the fact that the iron becomes magnetised by the passage of the electric current through it. It becomes circularly magnetised—lines of force cut the wire which is suspended in the middle of the tube, and in cutting it they exert a force greater than the E.M.F. that there would be if there had been no iron, which is easily magnetised, or if the iron had been replaced by copper, through which you cannot get so great an amount of magnetism so easily. This illustrates the general principle of skin resistance. I may say that in actual practice an engineer is seldom troubled with this except when he is coming to very large works where the cables are very thick indeed. With all the cables that we have been accustomed to in industrial work in this country there should be no trouble whatever; and it is only when you come to cables of 1in. or 2in. in diameter that the trouble would come to be serious. But when once you lower the frequency as we have done on the other side of the Atlantic, this trouble disappears entirely. Up to any size that we wish to use for our conductors there, there is not the slightest trouble from the extra resistance produced in this way.

(To be continued.)

ON THE RECENT DEVLOPMENT OF THE SINGLE-ACTING HIGH-SPEED ENGINE FOR CENTRAL-STATION WORK.*

BY MARK ROBINSON, MEMBER.

(Concluded from page 572.)

A discussion upon the economy of the single-acting engine should include running expenses other than steam, but this would greatly lengthen the paper. Moreover, it is only users who can pronounce upon this question finally and with authority. That single-acting engines of the closed type are very economical in oil is generally allowed, and economy in attendance is also conceded. An engine which oils itself cannot want much looking after. Repairs are the only point which really admits of dispute, and these are dealt with under "durability" in the succeeding paragraphs.

Durability (*b*).—The idea that because a machine makes many revolutions a minute it must wear out more rapidly than a slow-running machine, seems to have the force of an axiom for some minds. Yet there is nothing axiomatic, nor even, to the instructed, probable about it. In the first place, high speed is a very winnowing fan, in the matter of workmanship. It is surprising what a slow-speed engine can endure for a season in the way of bad workmanship; but not so the high-speed engine. If it will run at all, there is probably no reason it should stop, so far as workmanship affects the question. In the next place, the piston speed is usually much lower than in slow-running engines, owing to the short stroke—about 525ft. a minute is the highest piston speed in any single-acting electric light engine. The wear of piston rings and cylinders is bound—other things being equal—to be proportional to the piston speed, and this applies also to valves and glands. In one important point, however, other things are not equal, but are largely in favour of the single-acting engine. The system of packing rings previously described, which cannot be used in double-acting engines without much complication, has decisive effect upon cylinder wear; and even if one went back to the records of the old vertical beam engines, which used steam at 30lb. per square inch and have been described as "revolving occasionally," it may be doubted whether such evidence of good wear could be found as is now to be quoted in favour of the fastest-running engines.

The makers of the Willans engines have for some years past lost no opportunity of obtaining and recording exact measurements of wear, where they have been called in to carry out overhauls or examinations. The results are systematically recorded, and they show, speaking generally, an absence of

* Paper read before the Institution of Electrical Engineers, May 9.

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wear beyond all claims made or expectations formed by those interested in the engine. On March 9, 1895, a G G, or 80-i.h.p. compound non-condensing engine, No. 906, used for lighting one of the largest hotels in London, and stated to have run (at about 400 revolutions per minute) for 14 hours per day, including Sundays, was taken down for overhaul, never having been so much as taken down for examination since its erection in April, 1890—that is, five years previously. The report states that "all the parts were carefully measured, and the H.P. and L.P. trunks showed no perceptible wear, and were replaced the same as they were taken out. On measuring the H.P. cylinders, we found they were 2-1,000ths of an inch larger than our standard size, and the L.P. cylinders were the same; still they were quite round. All piston rings and gland rings were replaced without any repairs whatever. The whole of the repairs to this engine, including taking down and re-erecting, were executed in 24 hours."

It will be justly said that if such a report reflects great credit upon the engine, it reflects no less credit upon the engineer who has charge of it. The constant and heavy work in this case is no real disadvantage: the chances of corrosion during stops of a few days are more injurious. In a lighting station where work is more intermittent, and where during the summer engines are liable to be laid off for comparatively long periods, the wear (or corrosion) is greater, and the following is an instance of what is looked upon as heavy wear under such circumstances. The engine is of H H 12 size, No. 999, being of an exceptional type—that is, having 12in. stroke instead of 8in. (as usual in H size), and running under 200 revolutions instead of at about 380; it was one of a pair ordered to a special specification, and from the point of view of objectors to high speed it should give good results. It was erected in March, 1891, at one of the London electric lighting stations, and in February last it was taken down for an ordinary overhaul, and was re-erected. As the condition of the engine was manifestly good, and as it was non-standard, so that information about it had not the usual value, it was not measured, but hearing that a visitor to the station had measured the high-pressure cylinders while lying about, and had stated them to be much worn and considerably oval, the makers, though certain that the statement was a mistake, asked permission to take the engine down again, and made unusually full measurements checked by more than one observer, in the presence of the chief engineer of the station. It appeared that in one cylinder, though the ovalling ranged only from 2 to 7-1,000ths, there was in one part wear (in four years) of 28-1,000ths, or nearly 1-35th part of an inch; the other cylinder showed about half this wear, and no ovalling.*

The third instance is of an engine working under really good conditions—that is, driving a cotton mill, and working therefore for long hours, and with scarcely any stops exceeding two days. This engine, No. 1,253. of 650 i.h.p., commenced work in April, 1892, and though the cylinders had been taken down before, they had not been closely examined or measured. At Easter, 1895, it was thought desirable to have the engine closely examined, and between the Thursday evening and the following Sunday afternoon it was completely dismantled, thoroughly examined and measured over, cleaned, re-erected, and started under steam. There was no repair of any kind to be done, and but for the accidental breakage of some studs during re-erection it would have been running a few hours earlier. The report upon wear was most satisfactory, but the facts are best given in the words of the inspector sent by Mr. Michael Longridge, who supervised the examination on the part of the owners of the mill. This gentleman wrote: "The cylinders were taken down and pistons and valves out; the cylinders are 17in., 28in., and 40in., with 1ft. 6in. stroke. Revolutions, 206; boiler pressure, 160lb. I examined and gauged all the six cylinders with a very fine gauge, one that can be set to 1-10,000th part of an inch, and found H.P. cylinder about 1-1,000th part of an inch worn; I.P. cylinder 1-3,500th part, and L.P. 1-7,000th part of an inch worn; indeed, the tool marks had not properly worn out. The surfaces as smooth as glass. The pistons and rings seem to be very good, and the rings of the piston-valves also appear to be very good, all bearing well round; the piston-rods or trunks also appear to have good surfaces; also internal surfaces, where the valves work, seem good, and the rings of the piston-valves also appear very good, so that they scarcely appear to have been at any work. I must say that I never came across anything so accurately fitted together; even gauging the cylinders with the above-named fine gauge, I cannot say that I even found a slack place one way from another. Whether the engines are of good principle or not, the workmanship is good, which contributes to small wear and little friction. Crankshaft necks and crank-pins seem very good, being very smooth." "Whether the engines are of good principle or not" is valuable; clearly the giver of this emphatic testimony is no devotee of the single-acting engine. All brasses and journals, eccentrics, etc., were stated by the overhauling staff to be in perfect condition.

When the single-acting engine has run n years, it is always open to objectors to say (as they do) that no doubt it is good for n years, yet $n+1$ years will finish it. The argument admits of no refutation—that is, the present objectors may be right—for a year, though those of last year are refuted already. But reasonable men with such evidence as the foregoing before them will pay more heed to the counter-claim, which is, that the durability of the high-speed single-acting engine is not inferior to, but enormously exceeds that of the best double-acting engines, unless the latter revert to an archaic slowness of running, in which case their enormous size and cost will exclude them from practical consideration.

With many hundreds of single-acting engines at work, there are, of course, some cases of trouble. There have been broken crankshafts, though not in an unusually large proportion, if we exclude a succession of breakages in a single important station which attracted much attention. There were special reasons in that case which contributed to the result, but the plain and honest reason why the cranks broke (as with all other cranks which have broken since cranks began) is that they were simply not strong enough. The engines which formerly had a 4in. shaft have for some years past had 5in. shafts. The 4in. shafts have broken, and the 5in. have not, and are not likely to—apart from the effect of those occasional flaws against which no steel forging can be absolutely guaranteed.

Other cases of excessive wear, or of damage, when not referable to defective lubrication, may usually be traced to under-loading—*i.e.*, to running with so light a load that the pressure in the steam-chest becomes insufficient to hold down the lines of valves in constant thrust against the eccentrics. The single-acting engine has, of course, the defects of its qualities. Constant thrust is perfect so long as it lasts, but without it, the single-acting engine has no claim to admiration. For the pistons, and main moving parts generally, the question was settled once for all, so far as regards the Willans engine, by the well-known "air-buffers," which provide completely for cushioning, irrespective of change either of load or of back pressure, the distribution of the steam by the valves being absolutely untrammelled by any consideration of cushioning. Unfortunately, the air-buffers do not cushion the valves, and it is as important that the latter should be held closely down upon the eccentrics as that the connecting-rods should not leave the crank-pins. The line of valves is fairly heavy, and owing to the eccentric being seated on the crank-pin, though the stroke of the valves relatively to the ports is moderate, yet the total stroke is nearly as long as that of the pistons. "Holding-down power" is intended to be given by the pressure of the steam in the steam-chest upon the topmost valve, but if the pressure is too much throttled down, the "constant-thrust" element is wanting, and the parts have to be checked upon the up stroke, more or less, by the underside of the eccentric strap bearing against the sheave—a state of things which, at least in theory, is inadmissible in a constant-thrust engine. In practice, however, if there is good surface on the eccentric sheave, and a well-hardened pin at the small end of the eccentric rod, no serious results follow, provided the defect of pressure in the steam-chest is only occasional, and is not too considerable. Under such circumstances, however, it is necessary to look now and then to the eccentric straps, and take up the wear if necessary, and to be warned in time if the engine begins to run noisily. The lesson of the wastefulness of running an engine at light load, if it can possibly be avoided, has now been so well learned that in lighting stations at least (except, perhaps, in alternating stations where parallel running is not practised) there is little danger of the load, and consequently the steam-chest pressure, being allowed to fall low enough to jeopardise the "constant thrust" of the eccentric straps; but where such a probability exists it adds a reason for using variable expansion gear, which of course secures the maintenance of high pressure in the steam-chest. In a throttling engine it is also easy to secure the required holding-down pressure on the valves by forming the little steam-chest dome which tops each line of parts as a cylinder, in which the uppermost of the line of valve pistons works. The top of each little cylinder is in communication with the steam-pipe outside the throttl-evalve, and so gives a constant down pressure on the valves, irrespective of throttling. Of course these fittings cost something, and they need special lubrication, so that it is only in very exceptional cases that it is worth while to fit them, and in such cases there are probably other sufficient reasons for using variable expansion gear instead. It is well to bear in mind, however, that in special cases the durability of the valve motion may require to be secured by special precautions; it is not absolutely assured under all circumstances like that of the main working parts.

* The statement which gave rise to the remeasurement was that one cylinder was fully ¼in. oval, and that there was much tapering and wear generally. It was made beyond question in absolute good faith, probably from using inadequate or extemporised measuring appliances. The remarkable point was that the visitor was an engineer, and stated that he had been provoked to measure the cylinders by being told that no wear would be found in them, but that, "as an engineer himself, and accustomed to measure cylinders," he did not consider the wear, as he supposed it to exist, was excessive for the time the engine had been running.

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Lubrication (*c*).—Where the parts of an engine lie permanently in the lubricant, both when running and when standing, the quality of the oil is of more importance than where it is used in the old-fashioned way. Free acid in oil, which is more common than is usually supposed, leads to corrosion, and in some few cases has caused serious trouble; the quest for a perfect crank-chamber lubricant which shall always be the same, is not quite ended yet. Cylinder lubrication has long ceased to trouble (if the user does not sacrifice everything to cheapness), but not so the other. Sometimes it would appear that acid is brought over in priming water from the boiler: in some cases it has been traced, with tolerable certainty, to special boiler compositions containing acids, which may find their way with priming water past the valves into the crank-chamber. The tests for acid, however, are comparatively easy, and its presence is soon shown by the rusty red colour which the lubricant begins to assume, and, in worse cases, by the condition of the parts. Prevention also is usually easy, as by the use of small quantities of soda, or of soft soap, added daily to the crank-chamber in very minute quantities: if there is much of it, it "lathers" so successfully that it drives everything else out of the crank-chamber. The "personal equation" enters much into this, as into other questions of engine management. There are many hundreds of closed engines running where trouble with lubrication has never been heard of, yet in a few, working apparently under identical conditions, everything is different. Where oil is of doubtful quality, temperature plays, or may play, an important part, and the advantage of keeping the crank-chamber cool has for some years been recognised. In the Willans engine cooling pipes are usually fitted in the crank-chamber, through which, if the engine works non-condensing, it is well to run a small stream of water. About one-fourth of the quantity which is supplied to the engine as steam per hour is generally enough, but it is sometimes a convenient plan to run all the feed water through. In a non-condensing engine the crank-chamber is hotter than in a condensing engine, because the main source of heating is conduction, by the walls of the crank-chamber, from the "exhaust-chamber" above. When the exhaust temperature is about 215deg., as in a non-condensing engine, the crank-chamber, of course, grows hotter than where the exhaust is at condenser temperature. 170deg. F. is a perfectly safe temperature for the crank-chamber, but the lower it is, the more one has, so to say, in hand; and it is such an advantage to have complete control over the temperature, that it is generally worth while to adopt the cooling pipes, even in condensing engines. The large ones are made, as shown in the section in the appendix, with a kind of water-jacket to the crank-chamber base. It is evident that the engines might be constructed with a more complete separation between the hot cylinders and exhaust-chamber, and the cool crank-chamber: there might, for instance, be an air-space and columns between those parts. But, as is true of many other possible minor improvements, the gain from this arrangement might be bought too dearly; it is cheaper to take easy precautions against small and infrequent troubles, than to make the engine larger and more costly, even if theoretically more perfect.

Vibration (*d*).—The increase of town-lighting stations gives great importance to this subject, but as it has recently been somewhat fully dealt with, as regards both engines for lighting stations and marine engines, in a paper contributed by the author jointly with Captain Sankey, R.E., to the Institution of Naval Architects, it is not proposed to treat it at length on the present occasion; it will suffice now to say only enough to show in what direction improvement is most probable.

In a recent well-known case, several single-acting engines, supposed to be remarkably free from vibration, have been removed from a London station and replaced by steam-turbines, as the only certain means of meeting the objections of persons living close by. What was the cause of the vibration, and how can it be avoided without abandoning altogether the accepted reciprocating form of steam-engine?

The station contained 10 engines of 200 i.h.p. each, and it is no exaggeration to say that a person standing on the great concrete block which formed the foundation for all the engines could scarcely tell whether those near him were running or standing. Yet complaints from houses at some little distance (rather than from closer neighbours) were evidently well founded. The engines had two cranks each, 180deg. apart, where there was an obvious couple which tended to set the engine rocking endways, and to give rise to vibration. But it was incredible that the huge block of concrete, measuring 88ft. by 24ft. by 7ft., could be tilted crossways by the couple between sets of pistons moving in lines only 2ft. 3in. apart. Besides, the effects produced and the known nature of the subsoil, led to the belief that the block was not so much rocking as lifting up and down bodily, and acting like a pump upon the water-laden soils below (the complaints were most serious after periods of heavy rain). It would have been easy to balance the "couple" if that alone were the cause, by dividing one of the lines of pistons into two, each of half the weight, and using cranks. This plan is described in Lowrie's Patent No. 3,040, of 1885, and it has also attracted attention recently. The other engine shown would have no tendency to rock endways, but it was soon seen that it would effect no improvement in the station referred to, for on closely examining the matter mathematically (in February, 1893) Captain Sankey found that in the engines in question, and, broadly speaking, in all vertical engines, the tendency to rock endways, by reason of an unbalanced couple, was much less important than the tendency of the engine, as a whole, to move vertically up and down, through a cause depending upon the obliquity of the connecting rod. Previous calculations had usually been addressed to balancing the couple as a practical solution of the whole vibration question, and though it was known that the obliquity of the connecting-rod had an effect on the result, it was believed to be disposed of by the statement that "the slight and immaterial errors due to the finite length of the connecting and eccentric rods need not be considered."*

The engines were central-valve engines of I I size, having lines of parts each weighing 420lb. They ran at about 350 revolutions per minute, and had a stroke of 9in.; the ratio of connecting-rod to crank was 4·77 to 1. The two points of maximum piston velocity are, of course, above half-stroke, hence the changes of piston velocity, and therefore the inertia forces are greater in the upper half than in the lower half of the revolution. Without going into details, it appeared that when each line of parts was near the top centre it exerted an upward pressure upon the engine of 3·54 tons, but when near the bottom centre it pressed downwards with only 2·31 tons. Twice per revolution there is a force of 1¼ tons trying to lift the engine, and twice per revolution this changes into a nearly equal force acting downwards. (The inertia curves establishing these results are given with the paper before mentioned.) A number of engines developing these unbalanced forces, and synchronising every few seconds, were probably well calculated to produce the results complained of. Needless to say, the two engines, as regards revolutions, stroke, and total weight of moving parts, would give exactly similar results in respect of the unbalanced vertical inertia forces acting upon the engine as a whole.

At the same time Captain Sankey investigated the inertia forces in a three-crank (I I I) engine, having the same revolutions, stroke, and weights of parts, but with three cranks at 120deg. instead of two at 180deg. Here the unbalanced vertical forces entirely disappeared, or rather, so nearly disappeared that they amounted to about 2lb. only, as against 1¼ tons. It was concluded that if three-crank engines were substituted for the two-crank engines, the vibration difficulties would be ended, but the engineer of the lighting company naturally hesitated to adopt a remedy based chiefly upon calculation, for, although such three-crank engines were running elsewhere, and with remarkable absence of vibration, there was nothing to show with absolute certainty that the mathematical reason was the right one. He therefore shifted the engines to another station, and put down steam-turbines instead, feeling sure that they would at least secure the object of getting rid of vibration. The result was naturally to give an impulse to the use of three-crank instead of two-crank engines for lighting stations.

In 1894 the proprietors of the Heilmann system of electric traction were in search of vibrationless engines to mount upon two very powerful electrical locomotives they intended to build, and they applied to the author's company. The engines were to be of 1,400 h.p. each, and as they were to stand fore-and-aft on the engine framing, and as no weight could be allowed in the nature of "foundation," it was decided to eliminate the "couple" as well as the vertical inertia force. This, it is hoped, will be effected by the design shown, proposed, in letters which crossed each other, both by the author and by Mons. Mazen, of the Compagnie des Chemins de Fer de l'Ouest, who is interested on the part of that company in the development of the Heilmann system. There are six cranks, virtually forming two groups, each representing a three-crank engine, with cranks 120deg. apart, and therefore, according to Captain Sankey's investigations, free from any tendency to vertical movement. If the two halves of the engine are thus free, the whole must be so. Each half of the engine, however, has a "couple," and tries to rock endways. It is designed to neutralise this effect by arranging the cranks, by inverting the two groups relatively to each other, so that they shall rock systematically towards and away from each other. Both groups being mounted on one base, and enclosed in one crank-chamber, stiff enough to prevent deformation, it is clear that the engine as a whole will be subject to no rocking effect, and as it is also free from any unbalanced vertical forces due to the finite length of the connecting-rods, it is believed that complete success will be attained. A dynamo is mounted at each end of the engine, so that each half of the crankshaft has only to transmit its own half of the power. It is evident that the two centre cranks might be replaced by one, their two lines of parts being also replaced by one of the same total

* Quoted from a patent specification.

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weight; the engine would then be five-crank, but it would lose certain advantages of interchangeableness of parts, and of manufacturing facility.

Two such double engines are now under construction for a large London station, but inasmuch as longitudinal stiffness is amply provided by the concrete foundation, it is unnecessary to place the two groups of cranks in one crank-chamber. Each set consists of two I I I—S engine, each of 360 i.h.p., and each engine coupled to a dynamo. The engines are to stand end to end, the bases being bolted together, and the crankshafts connected by a detachable coupling (the governors are driven by gearing, so as not to interfere with the coupling). The coupling of the cranks does not admit of their going together in any but the right position. Either engine may be used, for light loads, as a single unit up to 360 i.h.p., in a form little likely to give rise to vibration, while at full power, when under ordinary circumstances vibration might become more serious, it is hoped that by coupling together as explained it will be entirely got rid of. The more conclusive experiment, however, will be in the Heilmann locomotives, where the engines, instead of being on solid foundations, will be, of course, suspended on springs.

Perhaps the very simplest form of completely-balanced engine is one which was used in the earliest Heilmann locomotive. Two examples are shown—a compound and a triple-expansion. Of course, in both cases the total weight of the moving parts must be the same on the two sides of the crankshaft, and the cranks must be 180deg. apart, and the connecting-rods and cranks of equal length. Both engines provide for the varying inertia forces due to the finite connecting-rods. The forces vary at the same times and in opposite directions, and so neutralise each other completely, instead of only partially. This form of engine needs to be horizontal. If used as a vertical engine, one crank must be driven from below, which is practically impossible in a marine engine, and cannot be generally convenient in other situations. Since the cranks must be opposite, such an engine also cannot have the even turning moment of an ordinary three-throw engine, and for marine purposes it would require to be duplicated—*i.e.*, to have six cranks—for the sake of avoiding dead centres.

Numerous proposals have been made to balance engines by "bob-weights"—dummy pistons driven by eccentrics. The couples in an engine can be thus balanced: not the other forces, unless the bob-weights are placed below, and are as heavy as the pistons. The subject is, however, far too complicated to receive more than superficial notice here.

In addition to the foregoing matters, it might be of interest to say something about the governing of central-station engines. This subject, however, needs a paper, to say the least, to itself; moreover, experience with single-acting engines can teach no lesson substantially different from what may be learned from double-acting engines, unless it be that the former, by reason of high speed and many impulses per minute, and the small amount of steam contained within the engine at any one time, are somewhat easier to govern. As regards steady running, in the sense of smallness of variation in speed during each revolution the high-speed engine has, of course, enormous advantage. The engines before referred to as driving a flax mill in Belfast gives an almost perfectly straight line upon the recorder, although the instrument used could be set to feed the paper so quickly that the change of speed in each separate revolution was apparent; its effect was limited, however, to the width of a narrow line. In this engine, with three cranks, there were 900 impulses per minute, all exactly equal, and it was not wonderful that with a pulley flywheel weighing only six tons, and of 5ft. diameter, better results were attained than in slow-running engines with flywheels many times as heavy. The same remarkably steady drive has been observed in another engine of the same type (but with two cranks only) driving a cotton mill. This, of course, is not governing, but merely testimony to flywheel efficiency. It is a subject, nevertheless, of great importance, and one which perhaps was somewhat neglected in the earlier days of the high-speed engine, when flywheel power was certainly cut fine.

As the flywheels have been made more powerful, so have the governors. If central-station experience tells anything, it is that if you want prompt and sensitive governing and freedom from hunting, you must first provide a very powerful governor, and then give it next to nothing to do. The Willans governors are now, owing to the high speed of rotation, and the much heavier balls in use, enormously powerful in proportion to the work to be done, which consists only in moving the (piston) throttle-valve, and, in automatic expansion engines, the very small steam-valve which controls the relay cylinder. The consequence is that a very restricted movement of the balls makes the desired change in minimum time, while leaving plenty of margin to deal with unaccustomed resistance, due to such causes as dirt or neglect. It is hardly possible that the most powerful shaft governor can have as much power relatively to the calls upon it in shifting eccentrics, links, etc., as is possessed by the governor of any recent Willans engine.

There is no subject about which more confusion exists in engine-rooms than the relative parts played by the governor and by the flywheel. They are certainly closely allied, but very often when the governor is blamed, it is really the flywheel which is in fault—that is to say, with reference to the particular work the engine is called upon to do. On the other hand, many a governor owes its reputation to the flywheel, whose huge weight forbids the engine to take serious notice of a change of load, until the governor, possibly in itself neither a powerful one nor a good one, has had time to adapt itself to changed conditions. Of course, a heavy flywheel cannot affect the permanent change of speed due to a change of load, but it depends largely upon the flywheel whether the momentary variation shall be great or not.

The great question of throttling *versus* variable expansion has been fully dealt with by Captain Sankey in a paper read at the spring meeting this year of the Institution of Mechanical Engineers. It must suffice to say here that variable expansion is desirable for practical convenience, rather than for economy, in a great many cases, and for economy in some, but that in no ordinary case does the economy rise beyond a very moderate percentage, and that only through a small part of the range of variation of load. It is also established, upon the basis of Mr. Willans's experiments, that at very high loads (say quarter load, or even more) it is distinctly more economical to throttle the steam than to continue to make the cut-off earlier, and maintain the full pressure in the steam-chest—since in the latter case, for only a small useful load, the full initial condensation is maintained, and the full loss by radiation. When the initial temperature in the first cylinder is reduced (as it is by throttling) both these sources of loss are diminished. Perhaps the most useful effect of automatic gear is that, by its aid, an engine can be occasionally overloaded without having to carry the same late cut-off at all times. Where the normal load is also the maximum load (as it should be in lighting stations, where the plant works in parallel) the engine is, of course, designed to give that load economically—*i.e.*, with cylinders of such size as to give the full load at a moderate mean pressure. In this case when light loads are carried—if they ever are carried: it would be better to avoid them—it is not of much importance whether the power is reduced by throttling or by altering the expansion. Now, take such a case as that of electrical traction, where the average load is small, perhaps only half or two-thirds the maximum; it is evident that the cylinders, and the normal expansion, should be designed to suit the average load—but this cannot be done without the use of automatic expansion, because provision has to be made for the occasional overload. By automatic expansion it is possible to keep the cylinders of such an engine small, and suitable for the normal load, and yet readily take more power from it for short periods. The periods of overload are, of course, wasteful, but this is far less important than wastefulness during the much longer periods of average load.

The mode of varying the cut-off in the Willans engine is by a sleeve working upon the trunk or hollow piston-rod, where it passes into the steam-chest at the top (see description in appendix). There are inclined ports in the trunk and in the sleeve, and by rotating the latter by means of gear outside (or sometimes inside) the steam-chest, the cut-off is made early or late. The system adopted is one originally planned by the author, but which owes its practical form to improvements carried out by Captain Sankey. A throttle-valve is used, and on, say, a drop in load, reduces the pressure in the steam-chest in the usual way. The rotating sleeves are controlled by a small steam-cylinder, the piston of which is exposed to boiler pressure on one side and to steam-chest pressure on the other. On the drop referred to taking place, the piston moves towards the steam-chest, and the cut-off is altered, in the sense of being made earlier; means are provided to prevent too rapid movement of the cut-off gear in this direction; slowness or jerkiness of action is immaterial, because the throttle-valve has always control over the speed. As the cut-off changes, the pressure in the steam-chest gradually returns to what it was before, or nearly so. The return journey of the relay piston offers more difficulty, and if effected only with the apparatus as yet described, it would require a considerable permanent difference of pressure between the steam-chest and the boiler. Captain Sankey has made this unnecessary by providing that when the engine speed falls, the spindle which moves the throttle-valve shall also move a small valve which both cuts off the boiler steam from the relay cylinder, and allows the steam already in this cylinder to exhaust into the receiver or some other place of lower pressure; as the relay piston moves it makes the cut-off later. The point of cut-off is at all times indicated externally by an index and pointer, the latter forming also a handle to enable the gear to be worked by hand if preferred. The gear has the great advantage that by merely fixing a stop, the range of variation of cut-off can be limited, so that, on the one hand, the engine may not be grossly overloaded, and, on the other, the expansion may not be carried too far for economy. In fact, the engine governs by varying the expansion down to a certain mean pressure (dependent, of course, upon boiler pressure and other circumstances) and below that by throttling, which is exactly the ideal arrangement for economy.

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In conclusion, the author thinks it may fairly be claimed that the single-acting high-speed engine has justified the favour shown to it by electrical engineers, in regard both to that which it has already accomplished and to the prospect which it holds out of further successful development. Its success, as in all similar cases, has but fostered improvement in other engines, and it may be doubted whether central-station engines in this country, either of the slow-speed class or of the high-speed double-acting class, or even the deeply interesting steam-turbine, would have attained to their present perfection had they lacked the spur applied by the progress of the Willans engine, and of others like it. For good or ill, the wide adoption of the single-acting high-speed engine marks a bold step in engineering. It is essentially of English origin and development, and its success bears witness that English engineers, though cautious, are also bold when boldness is called for. That it has fallen to members of this Institution to be leaders in so striking an innovation may perhaps earn a friendly tolerance for the many shortcomings of this attempt to place on record the more salient features of the system.

PHYSICAL SOCIETY.

At the ordinary meeting on May 10, 1895, Captain Abney, president, in the chair,

Mr. Herroun read a paper on the "**Iodine Voltameter.**" After referring to the usual methods of determining the value of the small currents used in calibrating galvanometers and other apparatus for measuring small currents, and discussing the errors to which they are subject, the author gave his reasons for selecting iodine. He did this since, with the exception of mercury in the mercurous state, iodine has the largest electro-chemical equivalent, and, in addition, by titration with sodium thiosulphate, it is possible to determine the quantity of iodine liberated with a greater accuracy than can be obtained by weighing a deposit of copper or silver with the balance. The solution employed in the voltameter contains 10 to 15 per cent. of zinc iodide. If care is taken to leave a small piece of metallic zinc in this solution, no free iodine is liberated on keeping, unless the solution is exposed to a strong light for some time. The anode consists of a plate of platinum at the bottom of a tall and fairly narrow beaker. The wire leading the current to the anode is encased in a glass tube, so that the iodine is only liberated at the bottom of the beaker, where on account of its great density it tends to collect. The cathode consists of an amalgamated zinc rod, which, to prevent loose particles of zinc falling down into the iodine, is surrounded by a piece of filter paper or vegetable parchment. In an electrolysis lasting for as long as two hours none of the iodine is found to diffuse up to the part of the solution near the zinc cathode. Where, on account of the extreme feebleness of the current employed, it is necessary to allow the electrolysis to continue for longer than two hours, a U tube is used with two small plugs of asbestos at the bend, the anode being in one limb and the cathode in the other. With this form of voltameter, even after the current has flowed for several days, no signs of iodine have been found in the limb containing the cathode. On account of the production of electric convection currents, the iodine voltameter does not seem to be quite so suitable for accurate measurements of strong currents. After the current is stopped the zinc electrode is immediately removed, the solution stirred, and the amount of iodine liberated determined by titration with sodium thiosulphate. The author finds that a convenient strength of the thiosulphate solution is one in which 1 c.c. corresponds to the amount of iodine liberated by five coulombs of electricity. This solution contains 12·8375 grammes of pure recrystallised sodium thiosulphate per litre. It is possible to perform the titration to within 0·1 c.c., which corresponds to 0·5 coulomb, or if the electrolysis last one hour to $\frac{1}{720}$ ampere. In a comparison made with a silver voltameter, the current as deduced from the silver was 0·0264 ampere, and that deduced from the iodine 0·0266. The author considers that part of the difference may be due to the effect of oxygen dissolved in the solution of silver nitrate.

Prof. Carey Foster considered this process for measuring currents a most valuable one. The idea of using a volumetric method for measuring currents was to him new. He did not, however, see the advantage of using a substance with a high electro-chemical equivalent, if a volumetric method was going to be employed to estimate the quantity of the substance liberated. It would be possible to use a chloride, though in this case the titration would probably be less accurate.

Prof. Silvanus Thompson said he thought the method would be very valuable, but he would like to know if any error was likely to arise if too great a current density was employed. The number the author had assumed for the atomic weight of silver (108) was only approximate. If the more accurate value 107·7 were used, the agreement between the results obtained with the silver and iodine voltameters would be improved.

Mr. Trotter asked what was the largest current that could be accurately measured.

Mr. Enright said he had used porous diaphragms in iodine voltameters, and found that the iodine collected in the positive compartment, while the water was driven over into the negative compartment. With strong currents it was possible to get almost pure iodine left in the one compartment.

Mr. Watson thought that since the value for the electro-chemical equivalent of iodine used by the author was deduced from Rayleigh's value of the electro-chemical equivalent of silver, and that Rayleigh's experiments were performed in air, the difference obtained with the silver and iodine voltameters could hardly be due to the cause suggested.

Mr. Elder warned the members that volumetric measurements were not so accurate or easy as they seemed. He particularly mistrusted a solution of sodium thiosulphate, since he had found a solution of this substance to change even in 24 hours. The difficulty of accurately reading the burette might be overcome by weighing the burette and its contents before and after the titration.

The Author, in his reply, said that with the size of electrodes he used (about nine square centimetres surface) 0·1 ampere was the maximum current it was safe to use. The only substance likely to be produced by too great a current density was periodate, which, since it was insoluble, would immediately be noticed. The influence of the dissolved oxygen was only appreciable with small currents where the electrolysis lasts some time, while in Rayleigh's experiments large currents were employed.

The Chairman, while returning thanks to the author for his paper, mentioned that in his experience he had found zinc salts to be very untrustworthy.

THE SELECT COMMITTEE ON TELEPHONY.

The Select Committee of the House of Commons on the Telephone Service heard further evidence on Tuesday, Mr. A. Morley presiding.

The **Hon. J. G. Ward**, Postmaster-General of New Zealand, and member of the Legislative Assembly, was the first witness, and, in answer to the **Chairman**, stated that in the colony both the telegraphs and the telephones were in the hands of the State. The colony legislated in the first instance to prevent anyone else introducing the telegraphic or telephonic system. At the start they had in the colony 116 subscribers, and now they had nearly 5,000. The total cost up to the end of the last financial year was £104,500, and the total earnings £183,000. Against the total earnings they charged 10 per cent. for depreciation and interest on capital, cost of staff, rent of premises, and other expenses, leaving the net earnings £54,082. Even with their small system they were opposed to centralisation. Their experience was that subdivision of exchanges led to speed. The charge to subscribers was £5 per annum for business purposes within half a mile of the exchange and a mile for private houses, with a graduated increased charge for longer distances.

Mr. Dickinson, deputy chairman of the London County Council, stated, by way of supplementing his former evidence as to the unsatisfactory service of the National Telephone Company, that on May 6 of the present year a circular was issued under the authority of the County Council to the users of the telephone service in London, 7,359 in number. Each subscriber was asked whether, in his opinion, the existing service was efficient and satisfactory; if not, in what respects was it unsatisfactory; and finally inviting suggestions as to improvements. In reply, 2,536 replies were received, of which 555 subscribers expressed entire satisfaction and 1,981 were not thoroughly satisfied. Of the 1,981, 1,305 expressed general dissatisfaction, 350 were undecided as to making suggestions for improvements, and 326 expressed themselves satisfied, but suggested improvements.

Mr. Forbes, president of the National Telephone Company, was next examined. He said that in the matter of the circular issued to the users of the telephone the company rather scored over the County Council as in response 2,346 subscribers signed unconditionally, 266 signed with qualifications, 43 were in favour of the County Council, and 36 refused to sign. He narrated the history of the telephone company, and cited a variety of statistics showing its growth and development. The number of subscribers as at December, 1894, was 73,383, as compared with 27,706 in 1892. The number of towns and places supplied was 537, exchanges open 593, number of subscribers' lines 75,116, and number of telephones in use 86,032. The present ratio of effective calls per annum was 139,639,000, and as each conversation involved two persons, the caller and the called, the number of messages was 279,278,000. He then dealt with the complaint that the service was charged for at an extortionate rate, and stated that the average annual payment per line was £9. 2s. 2d. The term "subscriber" conveyed no meaning. The Midland Railway Company was a subscriber, although it had a great many lines. The company, he added, recognised that they were agents of the Post Office. He felt when he visited the Post Office that he was as much an official as anyone else. The Post Office had charged them with a public duty, and they recognised that it was their duty to adapt themselves to the public convenience. At the end of this year London would be entirely served on the metallic system. That was a serious undertaking, having regard to the disturbance which inevitably must take place to the service while the change was being effected. He had no doubt the greater part of the complaints during the last three or four years in London was due to the change of system.

The committee adjourned till to-day (Friday).—*The Times.*

Electric Light Legislation in Ceylon.—With the advent of the electric light in Ceylon it has been thought necessary to introduce an ordinance to provide for the protection of person and property from risks incidental to the supply of current.

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COMPANIES' MEETINGS.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

The thirty-sixth ordinary general meeting of this Company was held at Winchester House on Wednesday, Mr. C. W. Earle occupying the chair.

The **Chairman** said that the report was the least satisfactory in its results of any they had had to submit since 1882. He did not know to which side of the table more sympathy was due—whether to the shareholders for their long-continued self-denial in restoring the Company to its present position of credit, or to the directors, who were disheartened at finding the poor dividend they had been in the habit of giving diminished, and all the labour which had been devoted to supplying a substantial service rendered almost fruitless to the ordinary shareholders. The only consolation the directors had was that the causes of this unfortunate condition of things were entirely beyond their control. At the last meeting he alluded to one or two of these cause, and notably the decline in the business of the West Indies, the fall in the value of sugar, and the increased skill with which merchants used the codes. In 1869, when the Company was first started, the Colonial Governments laid down a tariff with a minimum of 20 words, and it was only in deference to the growing custom among telegraph companies that the word "rate" was introduced some 12 or 15 years ago. By the introduction of that the average message, instead of being 20 words, was now about 7·25 words. The expenditure was £1,011 more than in the corresponding half-year, of which £952 was due to circumstances over which they had no control, the winds and waves of the West Indian seas not having been tempered this half-year to the Company. They had received £1,022 less than in the corresponding period, and, with the £1,011 more expenditure, they had done less well by £2,033. Had they received that amount, they would have been able to pay the 6d. dividend. As to the prospects of the current half-year, the traffics were slightly diminished. The expenditure on cables he hoped would not be great, but at the same time, as announced in the report, the Company would lose £2,000 per annum hitherto paid by the Island of Guadeloupe. The prospects of the Company, therefore, were not on the whole very bright. It was rather curious that, while this diminution of revenue and the difficulties they were going through were apparent to everybody, meetings were being held in the principal colonies of the West Indies and resolutions passed calling upon the governors to put pressure on the Secretary of the Colonies to subsidise, at the cost of the English taxpayer, a single line of cable. This cable they were asking was to run into the middle of this Company's system, and reduce the receipts to about 3s. a word. He did not know whether there was any chance of such a measure being adopted, but it should be remembered that this Company's system was duplicated by the desire of the West Indian colonies, so as to supply a reliable service without interruptions, and it seemed rather hard that they should be agitating for a single cable. He did not much fear that the movement would have any effect, but at the same time they must always be prepared for some surprise of the sort One of the arguments put forward was the advantage of having cables passing through British possessions, but in the event of war with a continental Power there would be no more safety for tactical cables than for those belonging to commercial companies.

The report was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Manchester.—Tenders are invited by the Corporation for painting offices, etc., at the electric light station. Particulars and forms of Mr. Nickson, Town Hall, Manchester. Tenders by 12 noon on 27th inst.

Godalming.—The Town Council invite proposals for the installation of the electric light for public and private lighting within the borough. Further particulars may be obtained upon application to Mr. Samuel Welman, borough surveyor, Church-street, Godalming.

Oldham.—The Corporation Electric Light Committee require tenders for supplying two 200-h.p. steam-engines and dynamos, steam-pipes, etc. Specifications and forms of tender may be obtained on application to Mr. Arthur Andrew, Gas and Water Offices, Oldham, to whom tenders are to be sent, endorsed "Tender for Engines and Dynamos," on or before the 28th inst.

London, E.—The Shoreditch Vestry invite tenders for the wiring of the Shoreditch Town Hall, including supplying and fixing cables, wires, switches, switchboards, etc., for the electric lighting of the building. Specifications and particulars may be had of the lighting engineer, Mr. C. H. Doughty, at the Town Hall, Old-street, E.C. Sealed tenders, endorsed "Tender for Wiring, etc.," must be sent to Mr. H. Mansfield Robinson, solicitor and vestry clerk, at the Town Hall, by 10 a.m. on 31st inst.

Huddersfield.—The Electric Lighting Committee of the Huddersfield Town Council invite tenders for high and low tension cables, and transformers, complete in cast-iron cases, with switches, fuses, and covers, required during the ensuing twelve months. Specifications and form of tender may be obtained on application to Mr. A. B. Mountain, borough electrical engineer, St. Andrew's-road, Huddersfield, to whom tenders are to be sent not later than the 1st June, endorsed "Tenders for Cables and Transformers."

Hanley.—The Corporation invite tenders for the supply, delivery, and erection complete of two Lancashire boilers and fittings, including steam receiver; water-tank and girders; arc lamps and posts; high and low pressure cables, street boxes, cast-iron pipes, etc., in certain streets in the borough; transformers, switches, etc. Forms of tender may be obtained, and specifications and plans inspected, at the office of Mr. Joseph Lobley, borough engineer and surveyor, Town Hall, Hanley. Tenders must be sent in to the borough engineer before the 27th inst.

London.—The Secretary of State for War gives notice that purchases of specific quantities of various articles will be made from time to time during the current year. Among them are electrical instruments for submarine mining and telegraph cable and wire. Manufacturers who may be desirous of tendering should apply to Mr. G. Lawson, director of army contracts, War Office, Pall-mall, S.W., by letter, giving at least names of two well-known firms or public bodies who have purchased from them and are in a position to certify as to the quality of their productions. Applications unaccompanied by references will not be noticed. Firms whose names are already on the War Office list need not apply, as forms for tendering will be sent to them in due course.

Brighton.—Tenders are invited by the Corporation for (*a*) the preparation, supply and delivery at Brighton of cast-iron lamp pillars and copper canopies for electric light arc lamps; (*b*) the preparation, supply, and delivery at Brighton of cast-iron and drawn-steel bracket posts for suspending electric light arc lamps. Drawings may be seen, and specifications and forms of tender obtained, at the office of the borough engineer and surveyor at the Town Hall, Brighton, on payment of £1. 1s. for each specification. Sealed tenders, addressed to Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton, and endorsed "Tender for Cast-Iron Lamp Pillars" or "Tender for Iron and Steel Bracket Posts," must be sent to the town clerk's office at the Town Hall before June 1 for the former and May 27 for the latter.

Manchester.—Tenders are invited by the Paving, Sewering, and Highways Committee for the execution of the following works: Contract No. 1—viz., laying a system of underground telephone pipes, with brick inspection pits, service boxes, and other appurtenant works in the following streets: (Route 4) Portland-street, Princess-street, Hart street, Sackville-street; (4a) Altrincham street, Lower Albion-street; (4b) Charles-street, Carpenter-street; (4c) Hart-street, Chatham-street, London-road, Booth-street, Dale-street, Stanley-street; (4d) Dale-street, Spear-street, Bennet street; (5) Portland-street, Chepstow-street, Great Bridgwater-street, Albion-street, Little Peter-street, Greaves-street; (5a) Oxford-street, Hulme-street. Drawings may be seen, and copies of specification, bills of quantities, and form of tender may be obtained, on application at the city surveyor's office, Town Hall, Manchester, on payment of £5. 5s., which sum will be refunded on the return of the documents and the receipt of a bona fide tender. Sealed tenders, enclosed in the official envelope, to be sent in by 31st inst.

RESULTS OF TENDERS.

Coventry.—The tender of Mr. C. Haywood, jun., has been accepted for the erection of a generating station for electricity, car-shed, boilers, and dynamos, for the Coventry and district tramways.

Brighton.—The following tenders have been received by the Corporation for the supply and erection of boilers at the Corporation electricity works, and for the supply of cables:

Supply and erection of boilers.

H. and T. Danks, Limited, Dudley	£4,750
Yates and Thom, Blackburn	3,785
Hawkesly, Wild, and Co., Sheffield	3,750
J. Thompson, Ettingshall, Wolverhampton	3,660
Davey, Paxman, and Co., Colchester	3,644
Penman and Co., Glasgow	3,500
Fraser and Fraser, Limited, Bromley-by-Bow	3,486
R. Hornsby and Sons, Limited, Grantham	3,300
Babcock and Wilcox, London (accepted)	3,100
Tinkers, Limited, Hyde, near Manchester	3,060
J. Fraser and Son, Millwall	2,938
Spur, Inman, and Co., Limited, Wakefield	2,870
Fleming and Ferguson, Paisley	2,760
E. Danks, Oldbury	2,627
R. Taylor and Sons, Marsden, Yorkshire	2,165

Supply of vulcanised rubber and lead-covered and armoured cables at per mile.

	A.	B.
India Rubber, etc., Company, Silvertown	£396	£297
W. T. Henley's Telegraph Company, London	337	279
Telegraph Manufacturing Company, Helsby	335	281
Fowler-Waring Cables Company, North Woolwich	328	268
W. T. Glover and Co., Salford	298	240
Callender's Bitumen, etc., Company, London	290	255
Siemens Bros. and Co., London (recommended for acceptance)	289	239
British Insulated Wire Company, Prescot (accepted, but since withdrawn)	230	215

A, Three-core cable. B. Two-core cable.

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BUSINESS NOTES.

Worthing.—Mr. Mellor's Committee have confirmed the Worthing provisional order.

Falmouth.—The lighting of the town by electricity has been mooted at the Town Council.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,584.

Hove.—The surveyor to the Urban Council is preparing a report on the subject of the electric light.

Ashby-de-la-Zouch.—The Urban District Council have under consideration the question of lighting the town electrically.

Motherwell.—The Committee of the House of Commons on Unopposed Bills has passed the Motherwell Electric Lighting Bill.

Newport (Mon.).—A new museum has been built as an adjunct to the free library premises in Dock-street. It will be lighted by electricity.

Dundee.—Messrs. Lowden Bros. have obtained the contract for lighting the Samnuggur, Titaghur, and Victoria jute mills in India by electricity.

Epping Forest Railway.—The London, Walthamstow, and Epping Forest Railway Bill was read in the House of Commons on Monday for the second time.

Bangor (Wales).—Mr. Medhurst, who has been appointed consulting engineer to the City Council, is now preparing a report upon the electric lighting of the town.

Change of Partnership.—Mr. S. V. Clirehugh, A.M.I C E., A.I.E.E, of Temple-chambers, Brazennose-street, Manchester, has dissolved partnership with Mr. R. Wilson.

Walthamstow.—Mr. Mellor's Committee on Tuesday confirmed the provisional order made by the Board of Trade under the Electric Lighting Acts relating to Walthamstow.

Mica.—We are informed that Mr. Archibald Campbell, of 28, Gray's-inn-road, W.C., has secured a contract with the Admiralty for mica on behalf of Baxters and Macdonald, Dundee.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 19th inst. amounted to £1,141, as compared with £1,282 in the corresponding week of last year.

Brighton and Rottingdean Seashore Electric Tramroad Company.—The prospectus of this Company has been issued, the capital being £20,000. The share-list closed on Wednesday.

Winchester.—The provisional order made by the Board of Trade under the Electric Lighting Acts with respect to Winchester has been confirmed by Mr. Mellor's Committee in the House of Commons.

Richmond-on-Thames.—The Fire Brigade Committee of the Town Council have reported that the Local Government Board have sanctioned the loan for the Kew and Petersham fire-call extension works.

Walsall.—A meeting of the Town Council has been held, at which, in reply to Councillor Baker, the Town Clerk said that the Electric Lighting Committee hoped to be ready to supply current to the public by the end of August.

Weston-super-Mare.—The Urban District Council have instructed their clerk to take initial proceedings at once for a renewal or extension of the electric lighting provisional order which has been obtained for the lighting of the town by electricity.

Chiswick.—A committee of the Urban District Council have reported that instructions had been given to Messrs. Bourne and Grant to stop the erection of the shaft at the central electric light station pending a satisfactory agreement being entered into with the Council.

Ossett.—A meeting of the Town Council has been held, at which a letter was read from Mr. B. Greenwood, solicitor, Ossett, respecting the formation of a company for electric lighting, and the town clerk was instructed to reply stating that the matter was under consideration.

Railway Station Lighting.—It has been decided to light electrically the Tunbridge Wells Stations, on the South-Eastern Railway. The contract has been placed in the hands of Messrs. Drake and Gorham, of London, Manchester, Scarborough, and Tunbridge Wells.

Southport.—The Town Council have decided, on the advice of experts, to lay a single concentric cable of the same size as the present high-tension cables, rather than two cables in pipes as previously proposed. The object is to light the new infirmary and to supply current to houses on the route.

Wigan.—The Town Council have decided that the town clerk inform the Board of Trade that they have no observations to offer on the draft regulations and conditions which the Board have prepared for securing the safety of the public, and for ensuring a proper and sufficient supply of electrical energy.

Poplar.—A meeting of the District Board of Works has been held, at which a letter from the Board of Trade, transmitting a set of new rules and regulations for securing the safety of the public in regard to electric lighting, and asking for the observations of the Board thereon, was ordered to be left in the hands of the clerk.

Taunton.—The Town Council have decided that the electric lighting posts between the centre of the town and the railway station be taken down. They have also decided that the sum of £500 be paid to the Fowler-Waring Cables Company, Limited, on account of the cables supplied in connection with the arc lighting and the No. 2 sub-station.

City and South London Railway.—The returns for the week ending May 19 were £905, compared with £907 for the corresponding period of 1894, being a decrease of £2. The total receipts for the current period of the present half-year are £18,720 against £18,213 in the corresponding period of 1894, an increase of £507.

Aberdeen.—The Aberdeen County Council have received a letter from the manager of the Northern Electric Supply Company at Cults requesting the consent of the Council to an application to be made to the Board of Trade for a provisional order authorising the supply of electricity. This was, on the motion of the convener, sent to the District Committee.

Killarney.—The Town Commissioners have written to the Board of Trade informing them that the accounts for the years 1892-93 and 1894 of the Killarney Electric Lighting Company have not been lodged with the Board of Commissioners as required by the Board of Trade regulations, and enquiring what steps will be taken to have their regulations fully complied with by the company.

Windermere.—The District Council have held a meeting, at which the clerk reported that he had received a copy of the provisional order which had been granted to the Windermere and District Electricity Supply Company, Limited, of Troutbeck Bridge, by the Board of Trade, but it contained nothing of importance beyond what had previously been before the notice of the Council.

D. P. Battery Company, Limited.—This Company has been registered, with a capital of £10,000, to adopt an agreement expressed to be made between W. C. Johnson of the first part, B. Drake and J. M. Gorham of the second part, and this company of the third part, and to carry on business as manufacturers of and dealers in storage batteries and other electrical appliances, and as electrical engineers generally.

Colwyn Bay.—A meeting of the District Council has been held, at which Mr. Davies moved that the Council give instructions to their clerk to apply for a provisional order for supplying their district with the electric light, and that a committee be appointed to take any necessary steps to obtain further powers to spend money in advertising the town, etc. It was desirable to bring the gas company to their senses. Mr. Blud seconded the motion, and it was carried.

Cooling Apparatus.—A successful installation of cooling apparatus by means of compressed air has been satisfactorily completed by Messrs. Baird, Thompson, and Co., Limited, for Lord Wenlock, of Escrick, Yorks. (the present Governor of Madras). By this apparatus the whole of the estate dairy produce, butter and cheese factories, provision and poultry stores, etc, can be kept at a low temperature, even in the warmest weather, without freezing.

Drumcondra.—Mr. G. Collins, solicitor (Messrs. Casey and Clay), and Mr. W. Anderson, J.P., secretary to the Dublin United Tramways Company, have waited on the Town Commissioners and explained the object and scope of the Bill which the company are promoting in Parliament for enabling them to use electric power for tram traction. On the motion of Mr. McMahon, seconded by Dr. Eustace, a resolution was passed approving of the Bill, and adopting a petition in favour of it.

Surbiton.—The clerk to the Council has read a circular letter from the Board of Trade, enclosing a draft of the revised electric lighting regulations, and asking for the observations of the Council thereon. The Chairman said it was a technical matter which had come just at the right time, and he thought it would be just as well to refer it to the Electric Lighting Committee. This was agreed to, and the following gentlemen will constitute the committee: Messrs. Judd, Marshall, Lapage (the vice chairman), and Maddick.

Bury St. Edmunds.—The Town Council have received a letter from Messrs. C. Oliver and J. Vale Richardson stating that they were putting down plant for electric lighting to their premises in Abbeygate-street, and had been asked to supply tradesmen on the opposite side of the street. They asked permission to lay a pipe across the road for that purpose. Permission was granted subject to the Electric Lighting Act, Messrs. Oliver and Richardson to pay a nominal rent of 1s. per year, and entering into an agreement to remove the pipe if required, the work to be done to the satisfaction of the borough surveyor.

Kingston-on-Thames.—The town clerk (Mr. H. A. Winser) has written to the Board of Guardians that the Lighting Committee of the Corporation requested him to suggest to them the desirability of introducing electric light into the workhouse, and that if the Guardians contemplated doing so the borough electrical engineer would be pleased to give whatever information was wanted on the subject. The Chairman said the Guardians had already agreed that there should be electric light in the new infirmary. Perhaps it would be as well to wait until that installation was completed before they considered any extension of it. This was agreed to.

Bristol.—A meeting of the Sanitary Committee has been held, at which the acting clerk read some communications which had taken place between the surveyor and the tramways company with reference to the removal of the urinals, cab stand, and rest in Old Market street, if the tramways company would place their new lines for the electric traction trams nearer together than the present ones, in order that more room might be provided for the ordinary traffic. The tramways company wrote favouring the proposal, but it was agreed to defer the matter, in order to consult with the surveyor upon the question.

Aberystwith.—A meeting of the Town Council has been held, at which Councillor Thomas called attention to the subject of the

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electric light. He said the Council had contracted for the light to be on from sunset to midnight. He considered that this was an unnecessary waste of money, besides the light was not put on until an hour after sunset. He hoped, therefore, the company's attention would be drawn to the matter, and that they would not charge them for the time when the lamps were not lit. Alderman C. M. Williams proposed that the matter should be left to the Public Lights Committee. Councillor D. C. Roberts said that the committee had the matter in hand.

Liverpool.—A meeting of the Special Lighting Committee of the Corporation was held on Monday, Mr. Alderman Fred. Smith presiding, when the draft agreement between the Corporation and the Liverpool Electric Lighting Supply Company with regard to the purchase of the company's rights and plant in Liverpool by the municipal body at a cost of £400 000 was under consideration. It is understood that the agreement has been approved by both parties, and that the Corporation will become the owners of the undertaking in due course. Parliamentary powers must, however, be acquired by the Corporation to enable it to take over the concern, and it is expected that these powers will be secured during the present session of Parliament.

New London Mains.—Applications were approved of by the London County Council on Tuesday from the Vestry of St Pancras for the construction of a sub-station in Wells-street, Gray's-inn-road, upon condition that adequate means be taken to secure the efficient ventilation and drainage of the sub-station; from the House-to-House Electric Light Supply Company, for laying mains in and across Earl's Court-road, in Earl's Court square and road, and across Penywern-road; from the St. James's and Pall Mall Electric Light Company, for laying mains in Beak-street; from the City of London Electric Lighting Company, for laying mains in Martagon-place and across Sumner-street; and from the Westminster Electric Supply Corporation, for laying mains in Pollen-street.

Copper.—The copper statistics for the first half of May show that the consumption was 510 tons less than the deliveries in this period, and the visible supply is therefore so much larger—54,749 tons, against 54,239 tons at the end of April. With regard to the recent fall in Rio Tinto, there is no ground for it beyond the realisations of an eminent firm, who are known to have bought a large option for the call to the end of June. That the new agreement has not yet been signed is also true; but the reason is simply that, several of the largest producers in America being away, the others have stated that there is no pressing hurry to enter into a convention, since under no circumstances can the amount of copper available for export to Europe in the next 12 months exceed 60,000 or 65,000 tons—which is all that the agree ment stipulates for.

Stafford.—The Electric Lighting Committee of the Town Council have reported that the contractor has nearly finished the work at the supply station, and that the cables were in course of being laid down. On the consideration of the report of this committee, a discussion took place respecting fitting up private premises with the electric wires by workmen employed by the committee. Letters had been received from private firms complaining of the competition. Mr. W. H. Peach defended the action of the committee, saying that they had engaged competent men, and the committee contended that it was in the interests of the Corporation, as well as in the interests of the general body of the ratepayers, that the department's workmen should put in the fittings No amendment was moved, and the action of the committee was approved.

Huddersfield.—The Town Council have confirmed the minutes of the Electric Lighting Committee's meetings, which set forth that the borough accountant reported that the balance of unexhausted borrowing power for the purpose of capital works of this department amounted to £3,312. 17s.—£870 11s. 6d. in respect of buildings, repayable within 30 years, and £2,442. 5s. 6d. for general purposes repayable within 15 years—and the electrical engineer reported that the further amounts likely to be required would be £15,000 for purposes of buildings and £35,000 for general purposes. The town clerk was instructed to take steps to obtain powers for borrowing the sum of £50,000. The Plant Sub-Committee, after considering a report from the engineer upon the inspection of generating machinery at the electric supply station, recommended the adoption of Messrs. S. Z. de Ferranti's plant at £3,558.

Cardiff.—The Cardiff borough engineer, Mr. Harpur, states that satisfactory progress is being made with electric lighting in the town. There are now 60 consumers, using between 4,000 and 5,000 lamps About a quarter-past ten on Monday night every alternate lamp in the streets went out. A meeting of the Cardiff Lighting and Electrical Committee was held on Tuesday, when the clerk read a letter from the Local Government Board in reference to an application to borrow £3,500 for public lighting. The money is required to purchase the old brewery in Womanby-street for the purposes of an electric lighting station. The Board stated that they were prepared to sanction the loan as soon as they were informed that Jones's-court had been acquired and the question of ancient lights overcome. The chairman stated that the Corporation had arranged to purchase Jones's-court, so that was all right.

Dover.—A memorial has been received by the Town Council from the inhabitants of Snargate-street calling attention to the lighting of the street and suggesting that electric lights should be substituted. The memorial was signed by the whole of the occupiers of the street (191). Councillor Mackenzie said he believed that the electric mains were laid down the street, and he should move that the electric light company be asked on what terms they would light the street by either brackets or from light arches thrown across the street, which would doubtless be a most striking way of lighting a narrow street. The Mayor suggested they might approach the company as proposed; the idea of light arches was a splendid way of lighting Snargate-street. The motion was carried. The Board of Trade electric regulations were referred to Mr. Slingo for report, the town clerk stating that an important alteration had been made in them.

Newcastle.—Parliamentary powers having been obtained to work two large sections of the Newcastle tramway lines, the property of the Corporation, by cable, a proposal has come before the committee from a firm of electrical engineers to form a syndicate to work the proposed City-road line by the overhead wire system, the same as at Leeds to the Roundhay Park. They would guarantee 6 per cent. on the cost of construction, and limit the fare to one penny per mile. The proposal was adjourned to see if the promoters could induce the local authority of Walker, a populous place adjoining the city boundary, to agree to the extension of the line, and also to get over the difficulty of going through the part of the city to the central station, where overhead wires would be strongly opposed. The borough engineer submitted a report in regard to the Chicago tramways, which on three systems compared as follows: horses, 12·70d. per car mile; electricity, 8·45d. per car mile; cable, 4·99d. per car mile.

Post Office Telephone Pipes.—The Highways Committee of the London County Council reported on Tuesday as follows: "An application has been made on behalf of the General Post Office for the Council's consent to the laying by the Department of a line of 4in. trunk telephone pipes from the Victoria-embankment subway, across Westminster Bridge, and along the Albert-embankment. That portion of the application which relates to Westminster Bridge will be dealt with by the Bridges Committee; and as regards the Albert-embankment, we see no objection to what is proposed. We therefore recommend that permission be given to the Post Office authorities to place a line of 4in. trunk telephone pipes under the footway on the river side of the Albert-embankment, upon condition that the work be carried out under the supervision of the chief engineer of the Council, and that any damage that may be done in the execution thereof be made good by, or at the sole cost of, the Post Office authorities, to his satisfaction."

Luton.—The town clerk has reported that the Luton Gas Company have lodged a petition against the Luton Corporation Electric Lighting Order (No. 2 Bill), that he had had a conference with the parliamentary agents in reference thereto and generally on the whole question, that if the Town Council desired to go on with and support their order it would be necessary to engage counsel, probably an expert, and submit evidence before the Select Committee to whom the Bill would be referred by the House, and that it was necessary for him and the parliamentary agents to receive instructions upon the whole subject at an early date. The town clerk further reported that it was impossible to state what would be the costs in supporting the order, because at present it was impossible to say whether the opposition would be strenuous or otherwise. After considerable discussion, it was resolved that, in consequence of the importance of the subject, the Town Council, sitting in committee, do consider and decide what steps and course of action shall be taken in the case.

Telephony in India.—The *Indian Engineer* says: "The advantages afforded by telephonic communication are too obvious to require any advocacy on our part, and we have often marvelled at the want of enterprise which limited the benefits of the instrument to the large cities only, and even then to a very limited degree. To our minds the wires should have long ere this been carried to the towns neighbouring to Calcutta, especially to those where jute, cotton, and other industries exist. To the tea planter a telephone installation, if carried out fully, would place him in instant speaking communication with all his coolie lines, and much of the danger which, owing to the isolation inherent to the industry, is now ever present as part of a planter's life, would be eliminated. We are therefore gratified to notice that Mr. John B. Saunders, the lately arrived general manager of the Bengal Telephone Company, Limited, of Calcutta, has turned his attention to this subject. We have little doubt that the enterprise of the company in this direction will be speedily availed of, the more readily so when it is found that the cost of telephone installations, as are now offered, are exceedingly moderate, and are far outweighed by the advantages which must accrue therefrom."

Yarmouth.—A meeting of the Town Council has been held, at which Mr. Martins said they had every reason to be satisfied with the good progress being made with the lighting of the town. The number of applicants for the electric light was keeping up well, and as the plant was only laid down for 6,000 lights and some 4,000 were now in use, it became needful to have an enlarged plant. Mr. Preece was very well satisfied with the progress made in three and a half months. The street-lighting would not be so profitable as the shop-lighting, and the more they got of the shops the sooner would the town be lighted throughout. A lengthy report by Mr. Preece was then read. In it he said: "The development has been quite equal to anything you could have expected. Most of the electric works in the country are now paying their working expenses, a fair interest on the capital expended, and proper allowances for sinking fund or depreciation; and the progress you have made will, I am sure, not place your works among the exceptions, especially when you take into consideration the remarkably small capital outlay at which they have been installed." The Council decided to apply for a loan of £15,500 to carry out the proposed works.

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Morecambe.—The District Council have held a meeting at which Mr. Gardner said a committee had been formed to confer with the electric light company, and he would like to ask whether there was any report on the matter. Mr. J. Brown said the secretary of that company had promised great things, but nothing had been settled. Mr. Harper said a letter had been received from the electric light company, which stated that as most of the members of the Council were in favour of purchasing it, there was a favourable opportunity for so doing. The directors were asked to meet the committee, but only the consulting engineer's report was sent, which recommended an outlay of about £4 000 or £5,000. The secretary promised to send the auditors' report and balance-sheet, and also answer any questions the committee required, but there had been no reply nor had there been an official balance-sheet. He considered it very unbusinesslike. The Morecambe Electric Light Company announce the issue of 2,000 £1 5 per cent. preference shares for the provision of a new generating station, etc.

Applications for Provisional Orders.—The Highways Committee of the London County Council reported on Tuesday as follows: "On February 12 last, the Council directed that it should be suggested to the Board of Trade that in the orders for which applications had been made this year by the County of London and Brush Provincial Electric Lighting Company in respect of (*a*) Battersea, (*b*) Newington, and (*c*) St. Olave's district, the following words should be inserted: 'provided always that nothing in this order shall be held to authorise the undertakers to construct in or under the surface of any public street or place, chambers or receptacles for transforming apparatus of greater span than 3ft. and more than 2ft. 6in. in depth.' Of these applications, the first two have been withdrawn; and, with regard to the last, relative to the St. Olave's district, the Board of Trade has intimated that it thinks it undesirable to limit in the order (which can only be amended by a further order) the precise size of transformer-chambers, and is therefore unable to insert the clause suggested by the Council. We do not see that, having regard to the opinion expressed by the Board of Trade, anything more can be done by the Council with reference to this order."

Snowdon Mountain Tramroad and Hotels Company, Limited.—This Company was formed in November last for the purpose of (1) constructing and working a tramroad about 4¾ miles in length from Llanberis to a point at the summit of Snowdon; (2) acquiring a lease of and carrying on the Victoria Hotel. Llanberis, situated near the commencement of the tramroad; (3) erecting, furnishing, and carrying on the Summit Hotel at the upper terminus of the tramroad, 3,500ft above sea level. The capital is £70,000 in £10 shares and the issue is announced of 6,343 shares and £20,000, part of an issue of £35,000 4½ per cent. first mortgage debentures of £100 each. The list opened yesterday, and will close on or before Wednesday, 29th inst. The prospectus states that it is anticipated that the tramroad will he completed and equipped and ready for passenger traffic during the present season. The present issue of debentures is made to meet the expenditure upon the hotels, lands, and other matters not included in the contract for the tramroad works, the balance to be issued only if and when required. Shareholders will be preferentially considered in the allotment of debentures. The issue of shares is made at the request of the contractors, who have entered into underwriting agreements as to the subscription of the greater portion of the shares.

The Theft from the Brush Company.—At the Old Bailey on Monday, before the Common Serjeant, Horace Richard Eve, 21, clerk, pleaded guilty to stealing £237 10s, the money of the Brush Electrical Engineering Company, Queen Victoria-street. Mr. Campbell prosecuted. The prisoner had been for about six months a clerk in the employ of the company, whose premises were broken into under mysterious circumstances during the Easter holidays. The safe was opened with a duplicate key, but the cash-box was forced open, and the money in question was stolen. The premises were under repair at the time, and workmen were engaged there, and the prisoner, who was not suspected for some days, continued to perform his duties, but Sergeants Bryan and Oates seemed to have interrogated him rather closely, with the result that he (prisoner) disappeared. A report was publicly circulated that he (prisoner) had met with foul play, and nothing was heard of him until he was arrested in Aberdeen, when he boasted to the officer of the riotous kind of life he had had with the money, and the champagne dinners he had indulged in. He had spent a considerable sum of money on cab hire, some of the money he had lost in gambling, and some he had lent a friend. Prisoner had been convicted of forgery previously. The Common Serjeant sentenced the prisoner to 18 months' hard labour.

Ulverston.—The Rural District Council have held a special meeting to receive the report of the interview with the Board of Trade with reference to the Windermere and District electric lighting provisional order, and, if so determined, to rescind the resolution of the Council with respect to purchase by the local authority, and to pass further resolutions thereon. The Clerk (Mr. Dean) said after the last meeting of the Council Mr. Hodgson and himself proceeded to the Board of Trade, and had an interview with respect to Clause 59, which set forth the terms on which the local authorities might purchase at the end of 10 years. The objectionable portion of the clause, as altered by the Board of Trade, was "that no such sale shall be valid or binding unless the consent of the Board of Trade has been previously given thereto." The Council and the other bodies interested had thought this was binding them to something they did not approve of, but after some discussion they came away from the interview satisfied that the action of the Board of Trade would be rather favourable to the local authorities than to the promoting company, and therefore they thought the clause should stand. Mr. Poole, however, had suggested the addition of words to the effect that the agreement to purchase should be subject to such alterations and modifications as the Board of Trade might on such sanction being applied for determine to be just and reasonable. That would enable the Board of Trade to make any modifications that might be called for by the change in the production of electricity. Mr. Haines formally proved that the former resolution of the Council be rescinded, which was seconded by Councillor Kennedy and agreed to Councillor Haines further moved that the clause as altered by the Board of Trade be agreed to, with the suggested addition of the words proposed by Mr. Poole. Councillor Hall seconded, and it was approved of.

Coventry.—At a meeting of the City Council, Mr. Drinkwater asked when the electric light was to be given, and said people had the idea that it would not be available this year. Alderman Hill said there was no justification for the idea. There would shortly be a meeting of the committee The site of the electric light works is close to the west bank of the Coventry Canal. The necessary buildings have been recently erected, from the plans of Messrs. G. and I. Steane by Mr. C. J. Hill, and with Mr. Crawford as clerk of the works. The building consists of an engine-house 78ft. by 120ft, with chimney shaft, coal-stores, pumping-room, suite of offices, men's room, lavatory, and other accommodation. The engine-room is lighted by large windows at the sides, on higher and lower levels, and by clerestory windows, and also by a glazed lantern running down the entire length, with casements opening for ventilation. The buildings have slated roof and terra cotta dressings; in the engine-room the windows have cast iron frames and a wood-block floor is laid. The works were begun in August last, the amount of the contract being £6,800. The electrical equipment of the station is proceeding rapidly. Messrs. J. Fowler and Co., of Leeds, have a gang of men now employed, and it is hoped that the machinery will be running two months hence, although another month may elapse before the light will be available for the public. The boilers are in position and the engines are being erected. The high-pressure alternating-current system has been adopted, with low-pressure distribution. The present building is sufficient for considerable extensions of plant The plant at present being erected will be capable of producing current for 5,000 8-c.p. lamps. The work is being satisfactorily carried out under the supervision of Mr. G S Ram, who is acting on behalf of the Corporation, under the direction of Mr. Hammond, consulting engineer. At present the scheme does not embrace any public or street lighting. On the recommendation of the General Works Committee of the Town Council, it has been resolved to consent to the substitution of the Westinghouse system for the Thomson-Houston system in the equipment of the Coventry and district electric tramways.

Brighton.—A meeting of the Town Council was held on Thursday last, at which the Lighting Committee, in a special report, submitted tenders which had been received for the supply and erection of boilers and of vulcanised rubber and lead covered and armoured cables. As to these tenders, the committee stated that they were advised that a considerable saving at the electricity generating station would be secured by the use of boilers of the Babcock and Wilcox type, and they therefore recommended that the tender of Messrs. Babcock and Wilcox, Limited, to supply and erect three boilers of the total steaming capacity required at the Corporation electricity generating station and all other work in connection therewith for £3,100 should be accepted, and also that the tender of the British Insulated Wire Company, Limited, to supply vulcanised rubber and lead-covered and armoured cables at £230 per mile for three-core cable and £215 per mile for two-core cable, should be accepted. Councillor Berry, in moving the adoption of these recommendations, said the committee had in this taken the advice of their engineer, who had informed them that these boilers were largely in use at electric lighting stations, and that the three boilers, which possessed a capacity equal to six others, also enabled them to effect an economy in regard to the space that they would occupy in the works. The motion having been seconded, Councillor Broadbridge expressed a conviction that the committee had made a great mistake in not accepting the tender of Messrs Fleming and Ferguson to supply six of their boilers for £2,760, which was something like £340 less than the amount of the tender recommended, observing that the boilers supplied by the firm named had the highest reputation in the country. Councillor Horton Stephens said it was quite clear that in order to carry out their business the Council must incur this expense, and there was no doubt that the boilers chosen were the cheapest and enabled them to economise space and buildings. Councillor Evans supported the committee, remarking that he had more confidence in Mr. Wright's judgment than in that of Councillor Broadbridge in regard to the boilers. The report was then agreed to. On Monday the Lighting Committee reported that since the meeting of the Council at which the tender of the British Insulated Wire Company for the supply of vulcanised rubber and lead-covered and armoured cables was accepted, they had received a communication from the company stating that they had made a mistake in their tender, and asking permission to withdraw their offer for the supply of the cables The committee recommended that the British Insulated Wire Company should be allowed to withdraw from the contract, and that the tender of Messrs. Siemens Bros. and Co., Limited (which was the next lowest), be accepted at the prices named in their tender—viz., £289 per mile for three-core cable and £239 per mile for two-core cable.

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PROVISIONAL PATENTS, 1895.

MAY 13.

9406. **Improvements in electric switches.** George Hill, 70, Market-street, Manchester.

9429. **Improvements in apparatus for electrolytical purposes.** Herbert Guthrie, 46, Lincoln's-inn-fields, London.

9433. **Improvements in electrically signalling on locomotives and apparatus for that purpose.** Robert Burn and Leonard George Tate, 28, Southampton-buildings, Chancery-lane, London.

9442. **Improved means for insulating electric conductors.** George Gatton Melhuish Hardingham, 191, Fleet-street, London. (The firm of Felten and Guilleaume, Germany.)

9445. **Improvements in electric meters.** Albert Peloux, 11, Southampton-buildings, Chancery-lane, London.

MAY 14.

9478. **Improvements in heating and cooking by means of electricity.** Gilbert Scott Ram, 23, Warwick-row, Coventry.

9504. **Improvements in shades or reflectors for incandescent electric and other lamps.** Alfred Allen Barratt and the Artistic Letter Company, Limited, 57, Chancery-lane, London.

9513. **Improvement in electric lamps.** William Henry Sheppard, 52, Chancery-lane, London. (Complete specification.)

9515. **Thermo-chemical processes for generating electricity.** Robert Dunlop Cassells and George Dowie, 14, Lewisham High-road, New Cross, London.

9521. **A photographic telegraph recorder.** John Imray, 28, Southampton-buildings, Chancery-lane, London. (Ader's system.) (La Société Industrielle des Telephones and Clement Ader, France.)

9546. **Improvements in or relating to conduits for electric railways.** Eduard Lachmann, 45, Southampton-buildings, Chancery-lane, London.

9547. **Improvements in and relating to the attachment of an electric lamp to a cap or the like.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Alfred Rodriquez and Edward Dayton Rockwell, United States.) (Complete specification.)

MAY 15.

9582. **Improvements in electrical apparatus for transmitting signals between points or stations, such as street fire-alarm apparatus.** Egerton Goolden Pulford, 10, St. George's-crescent, Liverpool.

9636. **Improvements in electric arc lamps.** Siemens Bros. and Co., Limited, and Frederick Booker, 28, Southampton-buildings, Chancery-lane, London.

MAY 16.

9683. **Improvements in apparatus for lighting railway carriages by electricity.** Robert Bell, 62, St. Vincent-street, Glasgow.

9684. **An improved commutator.** William John Harling, 4, St. Ann's-square, Manchester.

9685. **An improved brush-holder for dynamo-electric machines and motors.** William John Harling, 4, St. Ann's-square, Manchester.

9695. **A new or improved hand electric gas lighter.** John Sibley Richardson and Samuel Jevons, 77, Colmore-row, Birmingham.

9698. **Improvements in electrically-driven pumps and in apparatus therefor.** Charles B. Crawshaw and Rankin Kennedy, Hubert-street, Leeds-road, Bradford.

9704. **Improvements in electric track switches.** Joseph Young Porter, 321, High Holborn, London. (Complete specification.)

9708. **Improvements in electric heaters or rheostats.** James Henry Delaney, 23, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, November 23, 1894, being date of application in United States. (Complete specification.)

9727. **Improvements in and relating to telephones.** Sir Charles Stewart Forbes, Bart., 45, Southampton-buiidings, Chancery-Lane, London.

9730. **Improvements in electric igniting apparatus for gas and oil lamps and burners.** James Tarbottom Armstrong, 45, Southampton-buildings, Chancery-lane, London.

MAY 17.

9779. **An improvement in secondary batteries.** William Mather, 28, Southampton-buildings, Chancery-lane, London.

9784. **Improvements in electrodes, pencils, filaments, or the like for electric lamps of all kinds.** Fernand Le Roy, 6, Lord-street, Liverpool. (Complete specification.)

9796. **Improvements in conduits for electric cables.** John Bonthron, William Hart, and James Sherren Lucas, 24, Southampton-buildings, Chancery-lane, London.

9806. **Improvements in diaphragms for use in electrolytical apparatus.** Roger Comboul, 46, Lincoln's-inn-fields, London.

MAY 18.

9816. **Electric carriage-wheel contact.** Edwin Robinson, 5, Glossop-buildings, Moston-lane, Failsworth, Manchester.

9850. **Improvements in electrical switches.** Charles Mark Dorman, Reginald Arthur Smith, and Herbert George Baggs, Ordsal Electrical Works, Salford, Manchester.

9864. **An improved automatic safety clutch applicable to the suspension of electric arc lamps and for other purposes.** Robert Cornelius Quin and George Joseph Phillpott, 18, Hamilton-road, Brighton.

9882. **Improvements in and connected with conduits for electric light wires and the like.** The Safety Tread Syndicate, Limited, Joseph Mason, and Jonathan Mason, 55, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1891.

1050. **Distributing electrical energy.** De Ferranti. (Second edition.)

1894.

1542. **Telegraphy.** Cox and Crowley.

8412. **Controlling electric currents.** Frazer.

8730. **Electric batteries for vehicles, etc.** Froggatt.

9605. **Electric motors.** Mordey.

10140. **Electric current regulators.** Hartnell.

10487. **Electrical measuring and signalling instruments.** Sullivan.

11160. **Starting electric motors.** Ravenshaw and others.

11452. **Electric conductors.** Crompton and Dowsing.

12140. **Electric igniters.** Swinton.

24588. **Phonographs.** Robinson.

1895.

60. **Arc lamps.** Stevens.

2913. **Controlling electromotors.** Devonshire. (Priest.)

4551. **Electrical cut-outs.** Claremont.

5500. **Incandescent electric lamps.** Lucchesini.

5699. **Arc lamps.** MacIntire.

6008. **Electric conductors.** Siemens Bros. and Co. (Siemens and Halske.)

6171. **Telephonic switches.** Stock.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅛-5⅜
Bournemouth Electric Company	—	—
Brush Company, Ordinary	3	2⅞-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2½
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	15½-16
—— 5 per cent. Debenture Stock	100	133-136
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	131-123
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	—
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1⅛
Elmore's French Company	2	—
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	½-1½
W. T. Henley's Telegraph Works, Ordinary	10	10-11
—— Preference	10	13-14
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅛-7¼
—— Pref.	—	—
Liverpool Overhead Railway	10	9½-9¾
—— Pref.	10	14½-15½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	½-¾
Metropolitan Electric Supply	10	10½-11
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	5⅜-5⅝
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Nom. Cum. Third Pref.	5	5½-6⅛
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	7½-8
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5½-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8¾
—— 7 per cent. Pref.	5	8½-9¼
Swan United	3	1¾-2¼
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7½-8½
Yorkshire House-to-House	5	5½-6¼

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NOTES.

Exhibition of Railway Appliances.—This exhibition, at the Imperial Institute, will be opened to-morrow (Saturday) at noon.

Fire at the Prague Exhibition.—The annexe of the exhibition at Prague containing the electric lighting machinery was burned down on Thursday last week.

Telegraphy in Warfare. — The Indian papers recently to hand speak highly of the telegraphic arrangements made in connection with the Chitral expedition.

Baltic Canal.—The German Emperor's marquee at Holtenau is to be constructed after his Majesty's own design. The dining-hall will be lighted by 150 electric lamps.

Waterloo and City Railway.—The Institution of Junior Engineers will pay a visit on Tuesday next, at 6 p.m., to the works in connection with this electric railway.

Eccentric Behaviour of the Electric Light.—According to Dalziel's Agency, a fire was caused last Friday night at the Comédie Française Theatre, Paris, "by the bursting of an electric light."

Forthcoming Book.—Mr. Gisbert Kapp has arranged with Messrs. Whittaker and Co. for a translation from the German of his new work on the alternate-current transformer. It will be published in the specialists' series in the autumn.

Telegraphy in Burma.—The Rangoon correspondent of the *Times* telegraphs that rapid progress is being made with the road and telegraph line to Keng-tung. The Shan chiefs are rendering valuable assistance. Both works will be finished by the middle of June.

Electric Motors on the Stage.—Some ingenious electrical contrivances have been placed in the Court Theatre in Monaco with a view to the more efficient and rapid performance of the work usually done by hand power. The current is taken from the electric lighting plant.

Electric Railways —A cablegram from the United States says that the Manhattan Elevated Railroad Company, which works the New York City elevated roads, has decided to change its motive power to electricity, and is selling an issue of Manhattan Consolidated bonds in London in order to provide funds.

Chinese and Burmese Telegraph Lines.—There has been presented to both Houses of Parliament a pamphlet forming No. 9 of the treaty series, giving particulars of the convention between Great Britain and China respecting the junction of the Chinese and Burmese telegraph lines, which was signed at Tien-tsin on September 6 last.

Telegraph Service Estimates.—The 1895-96 estimates for Civil Services and Revenue Departments were issued on Tuesday. A further sum of £3,890,050 is required to be voted on account for the Civil Services, and a sum of £1,430,000 for the Revenue Departments. The items under the last-named head include Post Office Telegraphs, £450,000.

Institution of Electrical Engineers.—The meetings of the Institution will be discontinued until the autumn. We are in receipt of the May issue of the *Journal* of the Institution, which contains, among other matter, Mr. N. S. Keith's paper on "The Electrolysis of Gold," and Mr. W. Langdon's on "The Employment of the Electric Light for Railway Purposes," with the discussions thereon.

Safety Rules for High-Tension Currents.—One of the duties of the forthcoming congress of German electrical engineers at Munich will be to consider an elaborate code of safety rules for high-tension currents which has been jointly prepared by the Verband Deutscher Elektrotechniker and the Elektrotechnischer Verein, and which is printed in the organ of these societies, the *Elektrotechnische Zeitschrift*, for May 23.

Electric Traction in Turin. — M. Gruslin, of the Società Belga delle Tramvie di Torino, is, it is said, about to receive a concession from the municipal authorities of Turin for the construction of an electric tramway in that city on the trolley system to replace the existing horse traction. It is proposed to employ motors of 25 h.p., which will give the cars a speed double that of the present trams. The new plant is estimated to cost 1,200,000 lire, or £48,000.

Electric Light for Mines.—Mr. Hall, inspector of mines in the Liverpool district, is strongly in favour of electricity for lighting, though he points out that a portable and thoroughly satisfactory miners' lamp is still to be invented. He does not consider the objection that an electric lamp would not afford any test as to the state of the atmosphere of a mine worth consideration, because such a lamp gives so much security compared with any of the safety lamps of the well-known patterns.

North-East Coast Institution.—We have received the May issue of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders, which contains the adjourned discussion on Mr. W. C. Mountain's paper on "The Design and Efficiency of Plant for the Transmission of Power by Electricity," and Mr. Mountain's reply; discussion on Mr. Henry Foster's paper on "The Application of the Electric Arc to Machinery and Boiler Repairs"; and a paper on "Turret-Deck Cargo Steamers," by Mr. S. O. Kendall.

The Electric Light in Russia.—The various buildings of the Kremlin, in Moscow, are, in view of the forthcoming coronation of the Tsar, to be electrically lighted by means of 2,000 16-c.p. incandescent lamps and 40 arc lamps. Messrs. Schuckert and Co., of Nuremberg, who are to provide this installation, have been particularly fortunate in securing Russian contracts for electrical work—for example, the lighting of the Imperial Palace at Gatschina, the Marien and Michael Theatres in St. Petersburg, and of the Imperial Grand Theatre in Moscow.

Electric Lighthouses in France.—The new lighthouse at Penmarch Point, Brittany, the thirteenth of those lighted by electricity on the French coasts, will be about 130 yards to the eastward of the present one. Its tower, which will be about 185ft. above high-water line, is being built entirely of the best description of granite, and the light will be of such intensity as will, it is said, enable it to be seen at a distance of nearly 100 miles in clear and from 25 to 28 miles in hazy weather, having an illuminating power of 10,000,000 candles.

The Lalande Microphone.—M. de Lalande has constructed a microphone, to the carbons of which he applies the system generally used in physical instruments to deaden the oscillations. This system consists in immersing in a liquid the oscillating or vibrating portions, or parts which are rigidly connected to them. To this end the carbons of the new microphone are furnished with pieces of ebonite dipping into a bath of mercury likewise in contact with the sounding-board. The mercury, it is asserted, deadens the vibrations of the diaphragm and the carbons.

"Franklinisation."—M. H. Bordier was the author of a note, entitled "Action of the Static Sparks on the Local Temperature of the Regions subject to this mode of Franklinisation," which was read at a recent

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meeting of the Académie des Sciences. *L'Industrie Electrique*, in referring to this communication, remarks that its nature does not permit of even a brief abstract being made of the paper, and then slyly pokes fun at the authors of "such antiquated and ridiculous terminology as Franklinisation, Faradisation, Galvanisation, and d'Arsonvalisation."

Electric Dispersion.—Mr. P. Drude, in *Wiedemann's Annalen*, describes a method for investigating the relation between the dielectric constant of a substance and the period of the electric waves traversing it, or what may be described as the electric dispersion of the substance. If the dielectric constant decreases as the period increases, there will be normal, if it increases, anomalous dispersion. For alcohol dispersion was found to be normal, and of the same order of magnitude as its optical dispersion. Water showed abnormal dispersion with the large wave-lengths used, whereas ebonite showed no perceptible dispersion.

Church Electric Lighting in Italy.—Considerable interest has apparently been manifested in Italy in the fact that the church of the Corpus Domini in Bologna, in view of a three days' congress which was to be held within its walls, was illuminated by electricity. Two 2,000-c.p. arc lamps lighted the body of the sacred edifice, converted for the nonce into a secular building, while the various corridors were fitted with 16 c.p. incandescent lamps. The current, which was furnished by a dynamo driven by a small steam-engine placed in a building some 60 yards distant, was divided into three circuits—one for each arc lamp, and the other supplying the incandescent lamps.

Electric Traction in France.—Some surprise has been expressed in France that a Belgian firm—the Société Anonyme d'Electricité (Bouckaert et Cie.), of Brussels—should obtain the contract for the conversion of the existing horse tramways in Toulon, some 10 miles in length, into electric lines. This company will supply 30 cars, each fitted with two 15-h.p. motors. There will be three dynamos in the station, each of 200 h.p. and having an output of 132 kilowatts at 400 revolutions a minute. The three steam-engines will be single-cylinder horizontal; the boilers semi-tubular. Overhead conductors will be employed, the return being by the rails.

Personal.—The Queen has conferred the Knight Commandership of the Indian Empire on Mr. William Robert Brooke, late Director-General of Telegraphs in India.—Mr. W. T. A. Emtage, M.A., of Pembroke College, Oxford, now professor of mathematics and physics in the University College, Nottingham, has been elected principal of the Wandsworth Technical Institute.—The Victoria University, Manchester, conferred honorary degrees for the first time on Wednesday. Among those honoured was Lord Kelvin. In the evening a banquet was presided over by Dr. Leech (chairman of the convocation), at which Lord Spencer (chancellor of the University), Lord Ripon, and Lord Kelvin spoke.

Long Telephone-Wire Span.—The telephone wire which has recently been stretched across Lake Valen, in Switzerland, is claimed to supply the longest clear span in the world—namely, 8,000ft. It connects Quinten, which nestles at the foot of the Leistkamm, with Murg. At the former place the wire touches land at a height of nearly 1,200ft. above the sea-level; at the latter it is fastened at an elevation of 430ft. Hitherto, in Switzerland, the longest wire span has been only 3,050ft. The wire, which at the lowest point is 140ft. above the surface of the lake, is 2mm., or 0·079in. thick. One large vessel and 16 small craft were engaged in the operation of placing the cable between the points mentioned.

Curious Accident.—A Welsh paper states that Mr. Harry Baskerville, of Carmarthen, lineman of the Postal Engineering Department, and his assistants were shifting a telegraph post and fastening a wire to a chimney near the Bridge Shop, Llandyssul, on Monday, when the wire snapped, pulling him after the ladder and swinging him clean over the house-top. In the act of falling he shouted to a man who was directly under him, "Look out below!" which caused that man to clear away, and he thus escaped serious injury. Mr. Baskerville had the presence of mind to prepare himself for the fall, and, landing on his side and hand, he escaped with a slight fracture on his forearm.

Rival Illuminants.—The Dresden Electrotechnical Society have held a joint meeting with the Prometheus Institute to hear a paper by Prof. W. Wedding on the latest advancements in lighting. The paper dealt mainly with acetylene, which he stated was cheaper than the incandescent gaslight. Touching upon electric lighting, he held that little progress had been made of late years in connection with the incandescent lamp. Arc lamps, which formed the most brilliant of any light, were not suitable for small candle-powers—an observation not very remarkable for originality. He, however, admitted that they were admirably suited for street-lighting and far superior to incandescent gas lamps.

The Therapeutic Action of Currents of High Frequency.—It is known, *L'Eclairage Electrique* remarks, that M. d'Arsonval has introduced into electrotherapy new processes of electrisation based on the employment of currents of high frequency. MM. Apostoli and Berlioz have been experimenting for over a year with one of his methods, self-conduction, upon 65 invalids, and they have come to the following conclusions: currents of high frequency, when they completely envelop the patient and act by self conduction, are inefficacious and impotent against the majority of hysterical troubles and against certain neuralgic complaints, but the same currents exercise a powerful influence on the nutritive energy.

Cutting Hair by Electricity.—To have your hair singed off by electricity is the latest development of the tonsorial art, says an American contemporary. The apparatus to perform this operation consists simply of a platinum wire stretched over a comb. By pressing a button in the handle of the comb current is applied to the wire, and it is heated to a white heat. The comb is passed through the hair, and as the wire comes in contact with the hair it is burned off, the end of each hair being cauterised as cut, which process prevents the loss of the oily substance with which the hair is filled. The apparatus is connected by flexible cord and attachment plug to a lamp socket, and can be used by any barber of ordinary skill.

Electricity at the Amsterdam Exhibition.—At the international exhibition in Amsterdam, which was opened a fortnight ago and will close in November, electricity figures in the second section of group II. under the following divisions: Electric light—arc systems: apparatus, lamps, and accessories; incandescent systems: apparatus, lamps, and accessories. Electric motors—tramways, underground mine railways and others. Various applications of electricity—galvano-plastics (galvanic silvering, gilding, and nickeling); materials and methods for welding iron, steel, and other metals; methods of transmission and of indication; alarms; telegraphic apparatus; railway signals; cables, wires, and insulators; electric batteries; dynamos.

Technological Exhibition.—A seven days' exhibition of specimens of the practical work of candidates at the technological examinations, held this month in connection with the City and Guilds of London Institute for the

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Advancement of Technical Education, was opened last Saturday afternoon at the Imperial Institute. The exhibition, which is the second of its kind, comprises specimens of cloth and cotton weaving, dressmaking, metal plate, plasterers' and plumbers' work, mechanical engineering, carpentry and joinery, cabinet-making, and bookbinding. The examinations have now been held for 17 years, and the work is mostly done in workshops attached to schools or factories all over Great Britain, and, to some extent, in Australia, New Zealand, India, and South Africa.

Mason College, Birmingham.—A notice has been issued concerning three Priestley Scholarships in Chemistry, two Bowen Scholarships in Engineering, and one in Metallurgy, which were founded by the late Mr. T. Aubrey Bowen, of Melbourne. They are intended to encourage and afford facilities for the higher study of these subjects in Mason College, where they are tenable for one year, with the possibility of renewal at the discretion of the council of the college. The annual value of each is £100. Although, naturally, good work done at Mason College will be regarded as a specially favourable qualification, the council have thrown all the scholarships open to general competition. The first award will be made in September next, and all particulars may be learned on application to the secretary of the college.

Spiral Wall Socket.—Heretofore, when brackets or other fittings have been fixed to brick or plaster walls it has been necessary to drill a hole in the wall with a chisel, plug this with wood, and then use the latter as the support for the object intended to be fixed to the wall. Mr. Julius Boeddinghaus, of Dusseldorf, Germany, has recently brought out a novel device for the ready adjustment of brackets of all descriptions. It consists in embedding in the wall, while the plaster is being applied, a metal spiral. When the wall is finished the spiral is firmly held in position and can easily be cleaned out. It then forms a socket into which the bracket can be readily screwed and held firmly. The device not only saves time, but does not ruin the walls, carpets, or ceilings, while at the same time offering an absolutely rigid hold for the bracket or other device. It naturally also allows of a ready removal of the bracket.

Rapid-Fire Electric Gun.—An electric gun has been invented by Mr. A. S. Krotz, electrician of the Springfield Street Railway, U.S.A. It is simply a brass tube, open at both ends, around which is wrapped insulated wire, in a series of helices from one end to the other, acting upon iron balls put in at one end of the tube and passing through with ever-increasing impetus. The special advantages claimed for the gun are that it may be made very light in proportion to its capacity for throwing balls; that it cannot possibly explode; that it is economical in operation; and that the limit of the number of balls it will throw within a given time is the number of balls that can be put into its breech. For field service it is claimed it will far surpass anything now in use. The inventor estimates that from 700 to 1,000 shots per minute can be fired. Tests have been already made that are said to have been highly successful.

Photography by Electric Light.—On the occasion of a representation of "Harischandra" by Mr. Balivala's company, at the Novelty Theatre, Bombay, in honour of the Hon. Mr. Pherozeshah M. Mehta, Mr. Shapur N. Bhedwar, says the *Indian Engineer*, took a photograph of the whole audience by means of electric light. The mode adopted by this gentleman was that he used 21 arc lamps of 2,000 c.p. each. A row of 10 lamps was placed at the front end of the stage, on the top of the proscenium, while two lamps were placed almost touching the stage in order to counteract the shadows of the top lamps. In addition to these, on the right-hand side of the dress circle a row of six lamps was fixed in step fashion—that is, the highest lamp at the back and the lowest in front. Similarly, in order to counteract the shadows of these lamps, two other lamps were placed on the left-hand side of the dress circle, and one lamp was hung in the centre of the theatre on the extreme top. Some idea of the extent of the lighting may be obtained when it is stated that the area of the theatre is about 350 square yards, and has sitting room for 1,200 people. The lamps were lent for the occasion from the electrical department of Messrs. Nowrojee Wadia and Sons, and by Mr. J. N. Tata. The whole of the installation was erected under the direction of Mr. Bhedwar by Mr. Jehangir Nowrojee Bellihomjee, a well-known electrician of Bombay.

Magnetism of Volcanic Rock. — Signor G. Folgheraiter is the author of an article in vol. iv. (1895) of the *Atti* of the Accademia dei Lincei, entitled "The Induced Magnetism of the Volcanic Rocks of the Terrestrial Magnetic Field." He has conducted experiments on volcanic rocks with the object of determining the quantity of magnetism induced in them after having been heated to such a temperature as to entirely lose their permanent magnetism in the case of both slow and rapid cooling, and he hopes to be able to deduce from these observations conclusions relative to the conditions under which the rocks were remagnetised that were permanently magnetised. The pieces of rock which were experimented with were cut into the form of small parallelepipedons, weighing about 50 grammes, and whose length was twice or thrice that of their other dimensions. Care was also taken that they were cut in the direction in which the original rock stood. The specimens of basalt examined, the author said, might be divided into two groups: (1) those which were primarily only weakly magnetised, and in this case, after heating to redness, the magnetisation always augmented, but in different degrees, in the various specimens; (2) those basalts which were originally powerfully magnetised, and in this case, after heating, the magnetisation was considerably diminished. In both groups the magnetisation suffered no change during three months, and sudden cooling gave the same results as slow cooling.

A Simple Electric Chronograph.—Mr. Carl Barus, in the *American Journal of Science*, describes a simple chronograph pendulum which is likely to be very useful to those who have no break-circuit chronometer or seconds clock at their disposal. It is a simple mechanism by which an ordinary seconds pendulum is both kept in motion and made to record its oscillations on one or more chronographs sharply. The heavy metallic bob of the pendulum is electrically connected with the knife-edge, and its top is surmounted by a soft-iron armature, which is attracted during part of the swing by an electromagnet, and thus kept in motion. A longer and very much lighter pendulum, consisting of a flat bob suspended by two wires, is suspended by the side of the first, and swings in the same plane, but with a longer period. As the heavy pendulum approaches it, it touches a platinum spring projecting from the other bob, makes current for a moment, and works the chronograph, and at the same time sends the current through the electromagnet. The contact is quite momentary, as the spring causes the wire pendulum to be hurled off ballistically. On its return it is brought to rest, without rebounding, by a stop, against which it leans till the seconds pendulum returns. The bob of the light pendulum is made up of two small square parallel plates, between which the wires and the platinum strip are clutched by a single central screw. A band of platinum foil is wrapped round the

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heavy bob in order to ensure reliable electric contact. The chronographs and the electromagnet are connected in parallel. The records show that the time of contact does not reach 0·1sec.

Electrical Competition.—The Société d'Encouragement pour l'Industrie Nationale offers some special prizes in the electrical industry and others. A premium of 2,000f. will be awarded in 1896 for a small domestic motor, working independently or connected with a central station, and having an output of from 6 to 20 kilogramme-metres per second. This prize has already been awarded four times: on the first occasion to a hydraulic motor, on the second to a steam-engine, on the third to a gas-engine, and on the fourth occasion to a system of house-to-house transmission of power. It is now desired to vary the form and system of the motors, so that it would seem that the society is anxious to see what electricity can do in connection with its offer. A premium of 1,000f. will be awarded in 1896, if it be earned, for a new alloy useful to the arts. The society is induced to hold out this prize for competition in view of the great results which have been achieved with aluminium, and of the possibilities that one or more of the newer metals may present of forming a useful and successful alloy. A premium of 2,000f. will be given in 1896 for an electric incandescent lamp of a decimal candle-power using 0·05 ampere at 100 volts. The object is to obtain a lamp of small illuminating power running at a high voltage. The last prize is one of 3,000f., which is offered for bestowal in 1897, for a treatise embodying important improvements on the present methods of producing permanent magnets. Competitors should forward their schemes, models, etc., to the Secrétariat de la Société d'Encouragement pour l'Industrie Nationale, rue de Rennes, 44, Paris, before December 31 of the year preceding the distribution of the premiums.

Deaths from Electricity.—Mr. A. J. Farnsworth, an American engineer, writes that it has been frequently pointed out that it is current, and not voltage, that kills, and that the human body is not at all like a voltmeter, or other device of constant resistance, which can always be placed across the terminals of the circuit for which it is intended. If we should attempt to name a voltage that is capable of being handled at all times, by all persons, and under all circumstances with impunity, we would be compelled to make it very low indeed. The writer would not dare place it above 50 volts, and deaths have actually occurred from contact with 50-volt circuits, although probably from leakage currents. On the other hand, many persons have received shocks from contact with circuits of several thousand volts without injury, and D'Arsonval cites the case of a man subjected to an E.M.F. of 2,000 volts for several minutes without any disagreeable results to speak of, beyond temporary unconsciousness. Of course, the reason for this great discrepancy is that the resistance of the body changes enormously under different conditions of contact. It is also exceedingly likely that different conditions of health in an individual render him at one time more likely to succumb to electric shock than at others. The writer is also convinced that deaths of persons shocked by electricity have been the result of fright and superstition. Recently a coachman was shocked from a 104-volt circuit, and, although he was entirely uninjured, it took several hours and many persons to convince him that he would not die. Pale and trembling, he expected each moment to be attacked by convulsions and other symptoms of the poison with which he apparently considered himself inoculated.

The Pollak Rectifier.—At a recent meeting of the Elektrotechnische Gesellschaft at Frankfort-on-Main, Mr. C. Pollak read a paper which treated of the various uses to which the arrangement that he has devised and denominates a *Gleichrichter*, or rectifier, can be put. The instrument, he said, was designed to charge accumulators by means of alternating currents and also, in conjunction with a battery, to give continuous currents, and his object has been to form out of the purely alternating-current system, by means of rectifiers and accumulators, a new composite method, with a view to restrict the size of central stations and to utilise them to the fullest possible extent. The switching, he continued, differed from the ordinary method in charging accumulators only in that the automatic switch is polarised so that it may immediately operate if the current should change its direction. The first installation of this kind in which rectified alternating currents for electrolytic purposes have been permanently used on a large scale was fitted up in the works of the author's firm. The municipal central station supplied all the energy required in the form of single-phase alternating currents at 3,000 volts. In the works the current was transformed down to 65 volts and then rectified. The current thus obtained served to charge accumulators as well as to run continuous-current motors, arc and incandescent lamps. There were four rectifiers for every 350 amperes required, of which two or three were incessantly, night and day, in operation. The rectifier needed no foundation and very little room and attention; in charging accumulators it did not require more oversight than a dynamo, as the brushes only had to be shifted at the commencement and towards the end of the charging. In working, Mr. Pollak stated, *in* conclusion, the current supplied by the rectifier differed in no way from the ordinary continuous current. The method is fully described and illustrated in the *Elektrotechnischer Anzeiger* of May 23.

Electric Gold-Dredging Plant.—An interesting account was given recently by Mr. Robert Hay, of the application of water power in producing electricity for use in gold dredging in Shotover River, New Zealand. The water is obtained at a creek 1½ miles distant from the dredging ground, and brought by a race cut in the side of the hill, or, in places where the ground is not suitable, in a timber flume to a pressure-tank at a level of 524ft. above the pipes at the generator-house. From this tank to the Pelton wheel the water is carried in rolled-steel pipes, constructed in lengths 19ft. 6in. bolted together by wrought-iron flanges riveted to the pipes. The prime mover of the generating plant is a 4ft. Pelton reaction waterwheel, upon the buckets of which the water, from a nozzle 1½in. in diameter, impinges at a pressure of 228lb. per square inch. This wheel drives two series-wound dynamos working at a normal speed of 700 revolutions per minute, each developing a current of 40 amperes, at an E.M.F. of 650 volts, or nearly 70 h.p. The dynamos are coupled in series. The conductors, of a length of two miles, are of No. 4 S.W.G. bare copper wire, and are supported upon insulators carried by cross-arms upon old 40lb. rails. The current is conducted to two motors in the dredge, one for driving a centrifugal pump and the other for operating the buckets, winches, and revolving cylinder. These two machines are duplicates of the dynamos, and are coupled in series, so that when the bucket motor is switched off, the pump motor absorbs the surplus power by increasing the speed of the pump, and causing it to throw more water. The dredge is constructed for the most part of steel, and is capable, when operating at a depth of 20ft., of an output of 90 cubic yards per hour. The dredgings are delivered through a revolving screen, for separating the stones and coarser material, upon baize tables set at an inclination of

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1 in 12. Two 10-ampere arc lamps light the dredge at night, and are joined in multiple series with the motors, with suitable arrangements for their control. The cost of the installation and the weekly working expenses are £7,000 and £35 respectively.

Electricity v. Coal.—Mr. Sydney F. Walker discusses this question in a Welsh paper. He says: "It is quite true that in order to generate electricity you must consume some agent in which some other form of energy, and preferably heat, is stored, and of all possible agents coal is decidedly the most economical. But oil is rapidly taking the place of coal for a great many purposes. Where electricity will come in is in economising the consumption of coal and of oil by enabling very large engines and boilers to be used at convenient places, and also by utilising the at present wasted natural sources of energy, such as the rainfall, the rise and fall of the tide, the wind, and even the direct rays of the sun. At present it is cheaper to burn coal or oil, and to use the expensive energy of steam or gas, than the energy of falling water, of wind, or the direct rays of the sun, because the coal and oil can be consumed in any convenient spot where the work is to be done, while the other sources of energy are available only at inconvenient positions. But the practical development of transmission of power by electricity is gradually changing all that. The increase of the efficiency of electrical power transmission and the growing familiarity with higher and higher voltages are bringing the natural sources of power more and more within the limits of practical usefulness. Already the dream of generations of engineers, the utilisation of the energy of the falls of Niagara, is an accomplished fact, in part at least; the city of Buffalo, some 17 miles away, being lighted by electricity generated by the energy of the falling water, and some of its factories having their machinery driven from the same source. It is but the development of this, certainly a large development, but one that may possibly take place within the lives of some of the present generation, for us to be utilising the energy of Niagara in the same way in this country. Long before that goal is reached, however, coal will have to fight for its own existence as an industrial necessity."

Cable Routes.—On Friday last Lord Rosebery received a deputation from the Association of Chambers of Commerce in favour of inter-Imperial postal and telegraph routes between this country and the colonies, and between the colonies themselves, without such routes passing through other countries. The deputation was introduced by Sir Albert Rollit, president of the London Chamber, who expressed the desire of the chambers for a more close connection between the colonies and the mother country, which was one of their chief objects. With this view they approved most heartily of the result of the conference at Ottawa, and were of opinion that as the mail service to the United States was already heavily subsided, a similar Atlantic route to the Dominion of Canada itself should also be similarly subsidised. He pointed out the dangers our commerce might incur in case of war by the passage through possibly hostile countries of the means of telegraphic communication between the mother country and the colonies. The proposals of the chambers were for an Atlantic line and for a land route through the Dominion of Canada, and two Pacific lines, to Australia and New Zealand, which would bring them in close contact with China and Japan, a matter which it was impossible to overlook at the present moment. To show how greatly the colonies desired this, he might mention that the Dominion Government, which already paid heavily, would be ready to increase the present subsidy to £175,000. What they really desired was an Imperial postal mail subsidy. The vessels for this service would cost £400,000 each, and be 20-knot boats, and the saving of time would be 29 hours to Montreal and 24 hours to Vancouver. But in addition to Canada, the Australian colonies would also be largely benefited. He concluded by presenting a memorial on the subject. Mr. Plummer (Newcastle), as an ardent advocate of Imperial federation, regretted that the initiative in this matter had been left to the colonies themselves, and not taken up by this country. Lord Rosebery, in reply, said he had no decision on the part of the Government to announce. The Government had received Lord Jersey's report and referred it to a departmental committee, whose report has not yet been received. The Government had the matter practically under consideration, and hoped to be able shortly to give a satisfactory reply.

Electrical Trades Section.—A meeting of the Electrical Trades Section of the London Chamber of Commerce was held on Tuesday last, Mr. E. Garcke occupying the chair. The proceedings took the form of desultory discussions, and the attendance was very small. With respect to the special committee which had considered the telephone question, the Chairman said so many opposing interests were representing that the conclusions arrived at were mainly of the nature of compromises. Mr. Sydney Morse regretted that no one had represented the Chamber before the Parliamentary Committee from a purely commercial standpoint. Mr. Garcke said the question of light railways would be referred to a joint committee of the electrical and engineering sections. A committee has been formed of various trades in the Chamber to consider the Factories and Workshops Bill, and the chairman undertook to attend it on behalf of the Electrical Trades Section. The Crystal Palace and District Electric Supply Company, Limited, wrote complaining of the manner in which rates were fixed, and it was decided, on the motion of Mr. Garcke, seconded by Mr. Morse, that a strong representation be made to the council to take into consideration the existing law of rating with a view to its adjustment. The National Traction Engine Owners' and Users' Association wrote with respect to the section dealing with the subject of electric traction. It was stated that Major Flood-Page was looking after this matter. A new general committee has been appointed by the Chamber to deal with the question of merchandise marks. Mr. Sellon was appointed to act on this, and the chairman said he would find a second representative. The section had under consideration whether they should offer a prize or prizes in electrical or other subjects under the commercial education scheme of the Chamber. It was decided to take no action. Mr. Morse brought forward the fact that the Board of Trade were reducing the period of 42 years for metropolitan electric supply companies to 42 years from 1888. He approved of the orders lapsing at the same time, but considered that the companies should as an offset have better terms. It was agreed to write to the Board of Trade setting forth these views. Mr. Morse also drew attention to the fact that the traction protective clauses were not always inserted in private Bills as recommended by the Select Committee of 1893. It was agreed to write to draw the attention of the authorities to this matter. The last business to be transacted was the consideration of the revised Board of Trade electric light regulations. It was arranged to send out circulars to the electrical supply companies in London inviting suggestions with a view to an interview being held with the Board of Trade officials, and to write to the Board of Trade that this course had been adopted.

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ELECTRIC LIGHTING OF TRAINS.—III.

BY R. W. WEEKES, WHIT.SCH., A.M I.C.E.

(Continued from page 588.)

MIDLAND RAILWAY COMPANY.

Although this company has now discontinued lighting its express trains by electricity, it has done so with regret, and the cause of the abandonment will be explained below. Mr. W. E. Langdon has from the first taken a lively and practical interest in the various methods of train-lighting, and his first attempt to light a train electrically will be of interest. The following is condensed from his remarks on the subject, in the discussion on Mr. Massey's paper before the Society of Telegraph Engineers and Electricians in 1884. A system of primary batteries was employed, the batteries being of the Holmes-Burke type.

A carriage, consisting of six compartments and a guard's van, was fitted with the incandescent light. There were two lights in one compartment, one light in each of the other compartments, and two lights in the guard's van. The battery was placed in the van. The wires were carried along the roof of the carriage, and the lamps were fixed in the inside of the roof in the same manner as were the ordinary oil lamps. The van was therefore capable of being uncoupled and coupled as required. The lamps used were of 5 c.p., and the illumination of the compartments was pronounced by Mr. Langdon to be very good, and a very great advance upon the oil lamps. Still, he thought improvements could be made. Although one could read very well in the compartment containing two 5-c.p. lamps, it was not so easy in the remaining compartments, which had only one 5-c.p. lamp.

The fittings of the first-class compartments absorbed very much more light than those in the third-class compartments, and that may have accounted for a better light being obtained in the latter. The battery consisted of 15 cells, three parts of five cells each. The E.M.F. of the battery was 1·85 volts, and its resistance was one-fortieth of an ohm per cell. The lasting power of the battery was said to be 10 hours. The battery received daily attention. The experiment was carried out in connection with the London and Bradford express, and the single journey occupied five hours five minutes. There was a certain time during which the light was made use of when the train went through tunnels; the consequence was that the light was not run economically. The liquid which kept the battery going had to be replaced daily. Mr. Langdon's experience with regard to the plates, so far as he was able to ascertain at that date, was that they required re-amalgamating about twice a week. The liquid employed was sulphuric acid (diluted 1 to 12) in the zinc cell, and a patent preparation, which Mr. Holmes termed oxydone, for the carbon cell. Fumes were given off by the battery, and it was necessary to carry them away. This was to a certain extent objectionable. In the experiment, the fumes were not found in any way to interfere with the comfort of those whose duties required their presence in the van. The experiment, so far as concerned the Midland Railway, was regarded only with the view of testing the applicability of the electric light to railway travelling, and, with respect to that, Mr. Langdon said the experiment was perfectly successful.

The question of cost he did not think it would be fair to go into upon so small an experiment. It was evident that the battery was run under exceptional circumstances, and was not at that time being used economically—a great portion of it being wasted. Mr. Langdon considered that the question of the cost as regarded lighting by a primary battery could not be dealt with until they had had some more complete experiments—*i.e.*, larger trains fitted. There was one point which it was perhaps desirable to draw attention to, and that was whether railway carriages should be provided with one or two lights in each compartment. His opinion was that no compartment should be without two lights, so that in the case of anything happening to one through the rupture of its carbon filament, or something else, there would be another lamp left to illuminate the compartment. If 10-c.p. or 20-c.p. lamps were used, that, again, would alter the arrangements for the source from which the lighting power was derived. Undoubtedly, the most complete way of lighting a train was for each carriage to carry its own source of light, but that was hardly possible when using the primary battery, for with primary batteries that require to be charged every day it would hardly be possible to take the cells out and replace them to the necessary extent. Also the question of the quantity of force that had to be provided must be considered, for whether it was a primary battery or whether it was a dynamo, a certain force would have to be provided for a certain number of carriages which would have to be lighted from that source. These were all questions which he imagined would engage the attention of those gentlemen who were engaged in attempting to introduce the electric light to railway travelling, but they were questions of moment, because there were no railways in the kingdom whose traffic was not subject to be broken up and put together in a very haphazard sort of manner. In some cases as many as eight or ten carriages might be found between the guard's van and engine, and in others perhaps only three or four carriages, and some system of controlling the power would be necessary. In the experiment on the Midland Railway they used a switch which was placed in the guard's van and under the control of the guard, who had the power of increasing or decreasing the battery power. He mentioned finally that, although the train had been running for nearly four weeks since the electric light was fitted, they had only experienced one instance of failure of the lamps, and that was due to the filament of one of the carbons being destroyed.

As is foreshadowed in the above, the primary battery system was not destined to be continued on the Midland Company's trains, and the question of electric lighting was held in abeyance till 1888, when the directors authorised Mr. Langdon to equip two trains to run between London, Manchester, and Liverpool. The first of these was ready in May, 1889, and the second followed shortly afterwards. One of them was wired upon what is known as the "parallel" system, and the other upon the "series" system—*i.e.*, in the former the lights and batteries were arranged in parallel, whilst in the latter the batteries were in series, the lights in each coach being worked from the cells carried by it. It is needless to say that this was done for the sake of comparison. The main advantage of the "parallel" system is that any deficiency in the electrical energy of one vehicle is wholly, or to a great extent, met by the efficiency of those adjacent to it—the one can borrow from the other. The main disadvantage of the "series" system is that a break in any part of the train—a loose connection, etc.—cuts off the charging circuit, and throws the entire onus of the lighting upon the batteries. But it is somewhat less costly, in that smaller conducting cables may be used. Experience speedily displayed the advantages of the "parallel" over the "series" system, and the arrangement of the second train was modified accordingly. In each case the electricity was generated by a dynamo driven by belting from the wheels of the guard's van.

The first dynamos were supplied by the Brush Company, and were similar to the machine described in my last article. The design and manufacture of subsequent dynamos was placed in the hands of Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne, and I had the honour while with them to prepare the drawings for the first set made. The following is a list of what this dynamo had to do automatically:

(*a*) To switch itself into circuit when its E.M.F. had risen to the required value.

(*b*) The E.M.F. must afterwards be practically independent of the speed.

(*c*) An automatic reversing gear must be provided to reverse the connection with a change in direction of rotation.

Mr. J. H. Holmes decided to use a Gramme-wound armature, which has not the self-regulating properties of the Brush open-coil armature. The E.M.F. of a Gramme armature is proportional to the product of the strength of the magnetic field into the number of revolutions of the armature. If, therefore, the field strength can be decreased in the same ratio that the speed is increased, a constant

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voltage will be obtained. To effect this, Messrs. Holmes arrange two dynamos, Q and R (Fig. 8), having their armatures upon the same shaft, so as to revolve together, but influenced by separate magnetic fields. Q is the main generating machine, the strength of the magnetic field of which is regulated by R. The magnets of both dynamos are separately excited from a set of accumulators, C (Fig. 9), those of Q being provided with two distinct exciting circuits. One of these is an ordinary high-resistance shunt

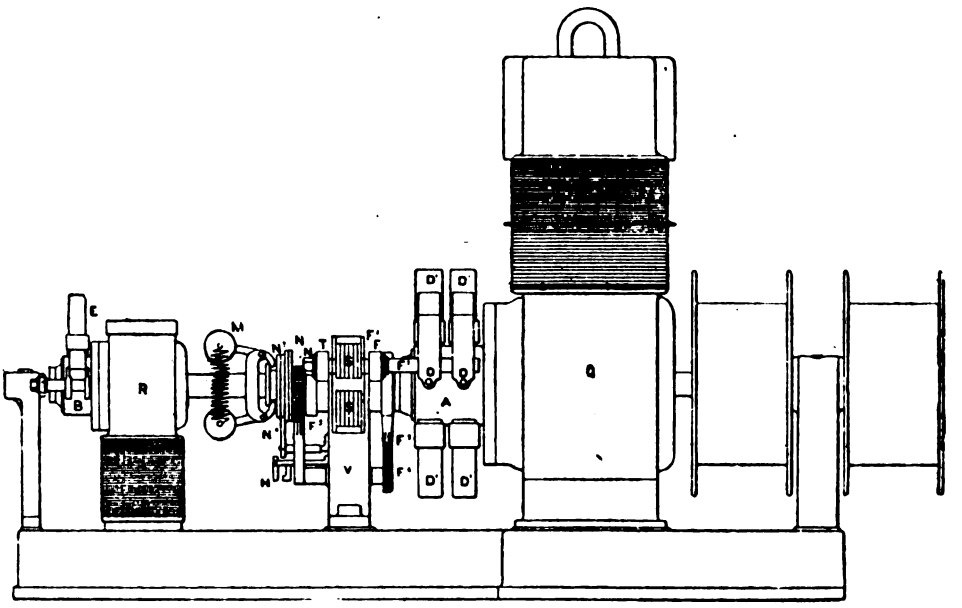

FIG. 8.—Elevation of the Holmes Train-Lighting Plant.

circuit connected to the accumulators, and the other, which is of less resistance, is coupled up to the armature of the small demagnetising armature of R in series with the accumulators. This regulating armature is so connected that its E.M.F. opposes that of the accumulators. The high-resistance shunt circuit is of such proportions that, at the maximum speed at which it is intended to run the machines, it will give, without the aid of the regulating circuit, a magnetic field of sufficient intensity for the required E.M.F. in the generating armature. When thus driven, the second exciting circuit ought to have no current passing through it, a result which is brought about by the E.M.F. of the regulating armature being at its highest speed equal and opposite to that of the accumulators, which provide the current for exciting the magnets. If, however, the speed falls, the E.M.F. of the regulating armature is lessened in the same proportion, and being no longer equal

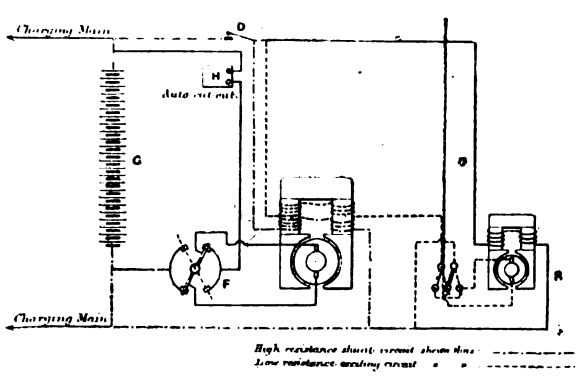

FIG. 9.—Sketch of Connections.

to the external pressure, permits a current to flow through the second or low-resistance exciting circuit of the magnets of Q, thus increasing the intensity of the magnetic field to make up for the reduction of speed. The result is that a practically uniform E.M.F. is maintained.

As will be seen from the diagram of connections, Fig. 9, the field of the small dynamo, R, is constant, as it is always united by the accumulators. All the automatic switching and reversing gears are controlled by the governor, M. The gear for altering the lead and reversing the polarity of the brushes of Q automatically when the axle commences to revolve in an opposite direction is shown in Fig. 10. The brushes, D (Fig. 8), are radial to the commutator, and are held in spring-holders, D^1, which are carried by bars, F^1, projecting from the brush arms, F F. These arms are mounted loosely on the inside pedestal, and they can be rocked automatically from one position to another, according to the direction of revolution of the shaft. The bars, F^1 F^1, are made to enter between one or other pair of contact jaws, S or S^1, which are connected respectively to the screw terminals, T T^1, for the circuit wires, so that as the polarity of the brushes is reversed on the reversal of the direction of rotation of the shaft, their connection with the circuit is at the same time reversed by the movement of the arms, F. The jaws, S S^1, on the right-hand side are coupled respectively with the jaws, S S^1, on the left-hand side by means of the copper bars, S^2. The brush arms and the contact bars, F^1 F^1, are

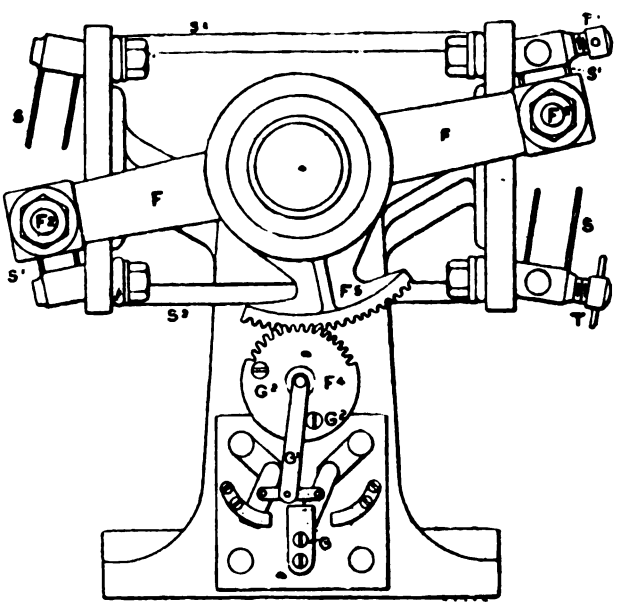

FIG. 10.—Reversing Gear.

moved over when the direction of rotation is changed by means of toothed gearing driven by the friction plates, N N^3. The plate N^3 is keyed to the shaft, but is free to be moved along so that the governor can draw it back as the speed increases.

The rotation of the brush arms at the same time reverse the connections from the demagnetising dynamo in the way shown at G, in Fig. 10. The next action of the governor is to close the shunt circuits of the two dynamos; finally, at a higher speed again, the main switch, which is of the quick-break type, is closed. The inverse operations

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take place as the speed decreases, so that the main current is always broken before the shunt is disconnected. The weight of the dynamo, with bedplate, is 15cwt., and the weight of the countershafting, pulleys, etc., 13cwt.

Fig. 11 and 12, which represent a portion of a guard's van, will serve to illustrate the arrangement adopted on the Midland Railway. Upon the axle, A (Fig. 12), are keyed two driving pulleys, B B, which transmit the motion by link belting to a countershaft, C; from this, again, two short link belts are led to the dynamo, Fig. 11. Duplicate driving gear is employed to meet breakage or other mishap to the belting of either pulley. It will be observed that the distances between the centres are very short. It was the only way in which the dynamo could be arranged without displacing other gear, which could not be done.

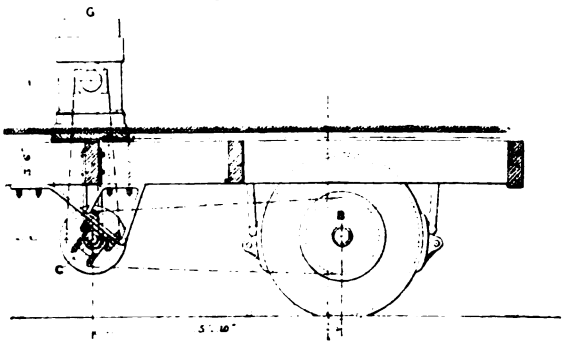

FIG. 11.—Sectional Elevation of Driving Gear.

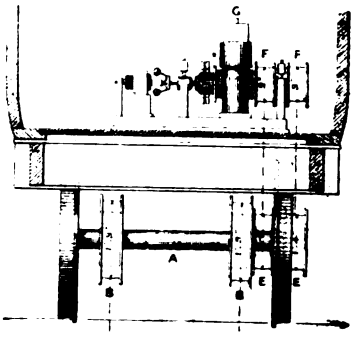

FIG. 12.—End Elevation of Driving Gear.

They may be conveniently arranged in boxes level with the footboards.

In arranging the accumulators in the train it is desirable, in order to meet the concussions due to shunting, etc., that the plates forming the cell shall be longitudinal to the train. In order to compensate for the increased pressure when the dynamo is in circuit, each vehicle is provided with an automatic relay which, when the voltage rises above what is required for the lamps, throws a sufficient resistance (usually 0·25 ohm) into the circuit.

With the object of distributing the current equally throughout the several parallels in the train, a small permanent resistance (0·25 ohm) is placed in each battery circuit. The output of the machine is scarcely affected by this arrangement, which, besides ensuring that each set of batteries or lamps receives its proper share of current, prevents an excessive current passing from a highly-charged set of accumulators into a set in an exhausted condition.

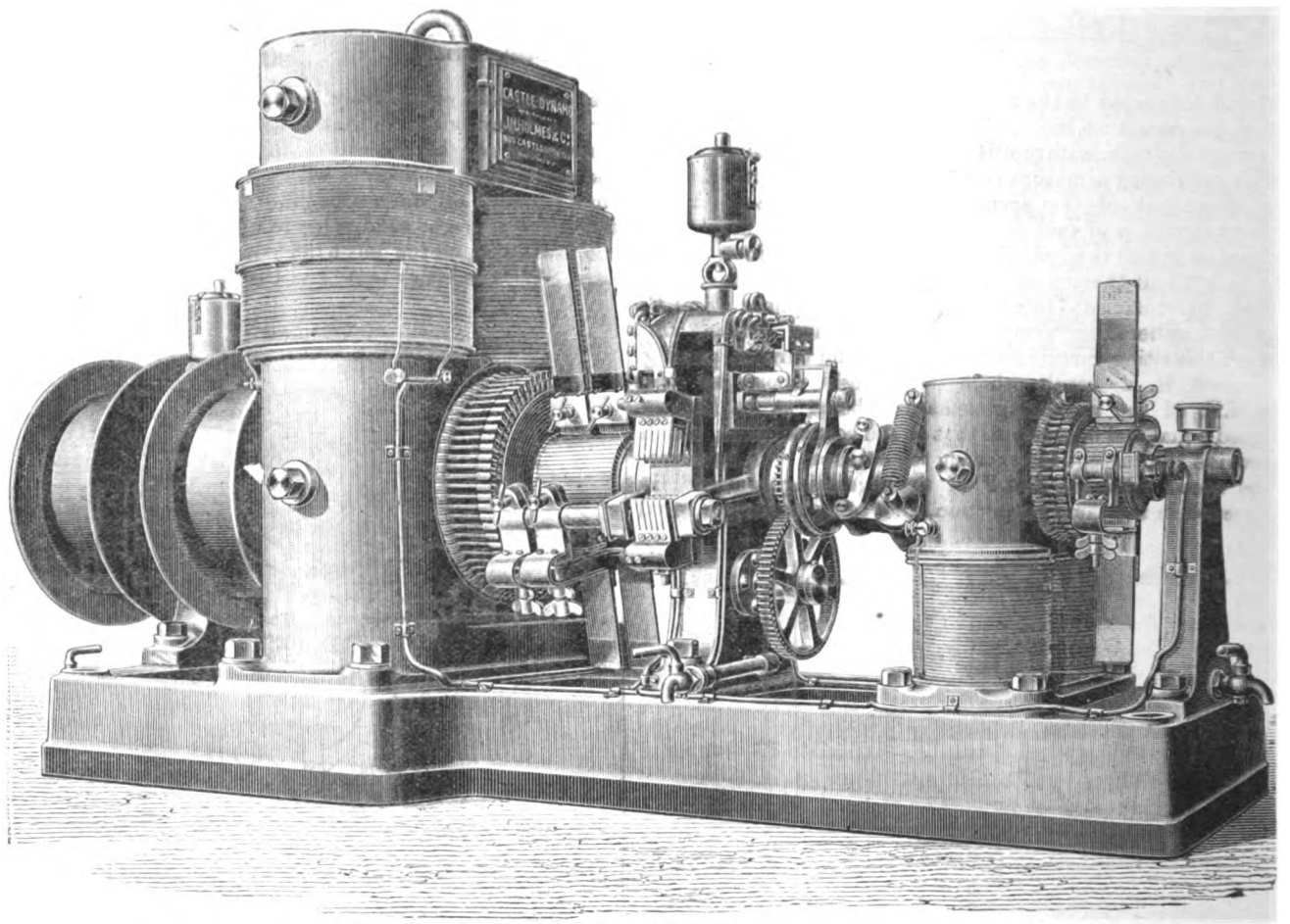

FIG. 13.

The accumulators employed were of the E.P.S. type, constructed and supplied by the Electrical Construction Corporation. With uncoupled trains the practice on the Midland was to place the dynamo in the guard's department and the cells in an adjoining one. The train is thus deprived of one compartment only—viz., that devoted to the cells. With main-line trains, where each vehicle carries its own batteries, the accumulators are of a smaller type—viz., C 15 for the Pullman cars and seven-compartment carriages, and C 11 for the smaller coaches. In all cases the electrical pressure is 35 volts, so that 18 cells are necessary for each

The important parts having been dealt with severally, the arrangement of the whole may now be described. Fig. 13 gives the view of the generating set. Fig. 14 represents a guard's van with dynamo and two coaches. From the two poles of the dynamo proceed the main cables, P and N, which are continued, by means of the couplings between each coach, throughout the train.

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Similarly, a third main, L—the lamp main—is carried from the switch, S, in the guard's van throughout the train. The switch, S, provides a means by which the lighting main, L, may be connected to the positive main, P. Between the charging mains, P and N, are arranged the accumulators, C C′ C″, and between the negative pole and the negative charging wire is placed the automatic relay, G, the coils of which form the permanent resistance of 0·25 ohm already referred to. The same wire which joins this relay

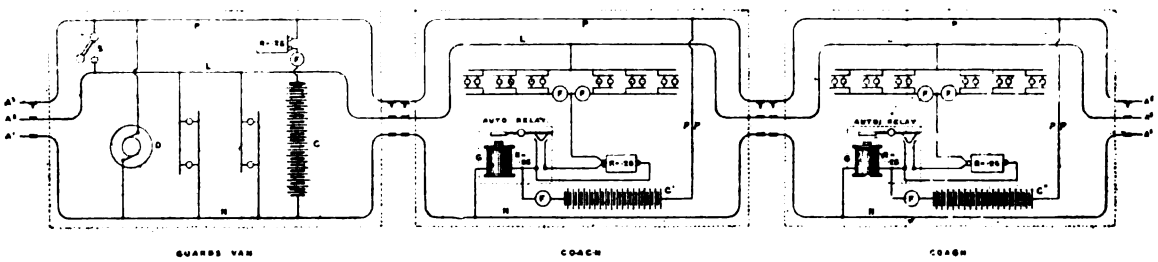

FIG. 14.—Method of Wiring the Carriages on the Midland Railway.

to the batteries makes connection with the lamp circuit, the opposite pole of which is joined to the lamp main. Safety fuses are arranged as shown at F.

ELECTRICAL COUPLING.

The difficulty of providing an efficient coupling is a matter of great importance. With trains which are not broken the details are simple, but where the marshalling of carriages has to be smartly dealt with at terminal or intermediate stations, it is essential that the coupling should not only provide for a good electrical connection, but also that it should admit of easy handling without the possibility of a mistake.

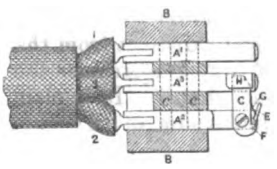

FIG. 15.

Fig. 15 is a sectional side elevation and Fig. 16 is a perspective view of one-half of a coupling enclosed in its iron case, and in the position which it occupies when coupled up for use. Each portion of the coupling is composed of three forked-shaped bars, Fig. 17, the projections, $a\ b$ and $a^1\ b^1$, which are split for the purpose of securing elasticity, interlocking the one with the other, and forming a reliable electrical contact between the opposite halves, A and A^1. Three of these bars are coupled together by insulating pins passing through the holes, c, and are then inserted in a block of ebonite, B. To the several bars, $A^1 A^2 A^3$ (Fig. 15), the main

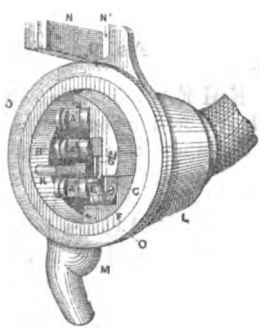

FIG 16.

cables are connected. A^1 and A^2 are joined to the cables forming the poles of the batteries, and A^3 to that forming the lamp circuit. A^2 has attached to it a movable connecting bar, C, which serves to join A^2 and A^3 when required, and thus complete the lighting circuit. C is provided with a trigger-piece, E, pivoted at F, free to be pressed inwards toward C, but otherwise retained in the position represented by means of the spring, G. Beyond its fulcrum, F, this trigger-piece is provided with a shoulder, which limits its movement away from C beyond the position desired. In Fig. 16 is shown a hooked rigid bar, K, the object of which is to operate the connecting-piece, C. K passes over the trigger, E, and forces back the connecting bar, C, until it rests in the shoe H attached to the bar A^2. On the two halves of the coupling being drawn apart, K engages with E, and thus draws the bar C over the shoe H in connection with A^2 to the shoe H^1 in connection with A^3. In this way, when the two halves of the coupling are pressed together, the cross-connection, C, is broken, and the three bars, A^1 A^2 A^3, are placed in contact, thus establishing the communication of the several cables.

The position of K in relation to C, when the coupling is closed, is that represented in Fig. 18. The hook, K, is not in electrical connection with either of the bars, but is fixed to the block of ebonite in which they are bedded. For slip-coaches, a special flat bar, not provided with a hook, is employed, the object being that the contact-piece, C, may be thrust back, but not again drawn over into the contact position when the coupling is pulled apart.

Fig. 16 shows the general arrangement of the whole, which is similar to that of the automatic brake coupling. M is the hook at its lower part, and N the straight bar, with a slot, N^1, so arranged that the bar, N, of the one

FIG. 17.

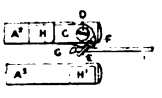

FIG. 18.

half-coupling shall enter the slot, N^1, of the other half-coupling, and the hook, M, of the one engage with the corresponding part of the other. O is an indiarubber ring fixed in an undercut groove formed in the flange of the metal case, L, serving to exclude the wet. The weight of the two, when hooked together and left suspended

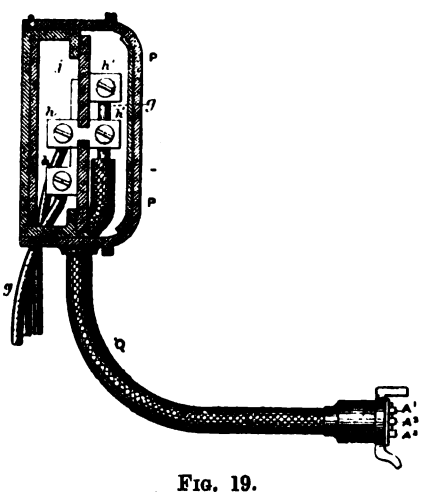

FIG. 19.

between the vehicles which they connect, draws them firmly together at the upper part.

Fig. 19 represents in sectional side elevation the half-coupling joined to the connecting-box, P, fixed on each end of the vehicle. The three cables, g, from the vehicle are brought up and attached to terminals, h, fixed to an insulating disc, J. To a continuation, h^1, of these terminals are attached the three leads, g^1, comprised within the combined cable, Q, and which are at their other ends attached to the bars, A^1 A^2 A^3.

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At a convenient point at each end of the vehicle is also placed a dummy coupling, which, as is implied by the name, is not electrically connected. It is composed of a block of wood, to which is fixed the hook, K, and is intended to provide a position of rest for the coupling when the train is broken up, and to act as an automatic switch. On the coupling being placed upon it, the connecting-piece, C (Fig. 15), is thrust back by means of the hook, K, and the lights are thereby turned out. If they are required to be kept on, it is only necessary to allow the coupling to hang down instead of placing it upon the dummy.

Remarks on the Midland System.

The reasons which led to the abandonment of the electric lighting of the trains on the Midland Railway to lines can only be conjectured by outsiders. The opposition of gas lighting was likely to be the most weighty of these. The light supplied electrically under Mr. Langdon's supervision was good and well maintained. The exigencies of the main-line traffic were exceedingly hard on the accumulators employed. Of course, a sufficient number of carriages has to be equipped to run the busiest portion of the year when long trains are required. The trains were repeatedly broken up, and it frequently occurred that the accumulators in some individual carriage enjoyed but for a short time the fostering care of the dynamo. The carriage would after that be left in a siding for perhaps two or three weeks and then suddenly be used again. As a result, the accumulators suffered, and the dynamos had to give an excessive current while keeping up the normal pressure of the lamps. The dynamo part was, I understand, perfectly successful, and maintained a good constant pressure independently of the speed. Then, after a time, the question of uniformity of lighting had to be considered, and the directors decided that the smaller competitor should go to the wall. I have been unable to ascertain recent figures as to the cost of maintenance, and shall refer to Mr. Langdon's paper again for the figures he published in 1891. The paper read by him before the Institution of Civil Engineers has been of great service to me while working up information on train lighting.

THE THEORY OF ALTERNATING CURRENTS.—V.

BY A.INST.E.E.

§ 14. **Circuits with Induction and Resistance in Series—Reactance.**—The importance attached to the presence of self-induction in a circuit has already been mentioned, and in this paper we propose to collect the various factors which have been considered separately, and which are connected very intimately in alternating-current circuits, and explain how to deal with the quantitative relationships between them. From § 1-§ 5 we know that

(1) L, the coefficient of self-induction in absolute units, represents the number of lines of force linked with the circuit due to a change in the current strength at the rate of one absolute unit per second.

(2) If L be given in henrys (practical units), its magnitude is 10^9 times the absolute unit.

(3) If a continuous current changes at the rate of C amperes per second, the inductance is L C henrys, and the counter E.M.F. or E.M.F. of self-induction, E_s, is L C volts.

(4) $L = 4\pi n^2 A/10^9 l = 4\pi^2 n^2 r^2/10^9 l = 4\pi^2 n^2 r^2 \mu/10^9 l$;

where n = number of turns in coil, r = radius of coil,
A = area of coil = πr^2;
l = length of coil in centimetres, and μ = permeability of core.

It is therefore evident that in an alternating-current circuit, containing a coil of inductance L, and in which a current of C virtual amperes with a frequency of $\frown\!\!\smile$ cycles per second is passing, the counter E.M.F. is $2\pi \frown\!\!\smile$ L C virtual volts. Since 2π is the number of radians corresponding with each cycle, therefore $2\pi \frown\!\!\smile$ is the angular velocity of the armature This counter E.M.F. is a function of the current traversing the circuit, and, as we shall see presently, it is one of the components of the impressed E.M.F. It is the existence of this counter E.M.F. that makes Ohm's law, as stated for direct currents, inapplicable for alternating-current circuits, since it reacts on the impressed E.M.F., and for this reason it is termed the *reactive E.M.F.*—that is, the *reactive E.M.F.* $= 2\pi \frown\!\!\smile$ L C virtual volts, or, in words,

Reactive E.M.F. = 2 π × frequency × henrys × amperes;
= angular velocity × henrys × amperes.

It will also be noticed that the equation $(2\pi \frown\!\!\smile \text{L}) \times \text{C}$ = reactive E.M.F. is of the same form as R × C = E, from which it follows that $2\pi \frown\!\!\smile$ L is a quantity equivalent to resistance, and for this reason it is measured in ohms. To this quantity—$2\pi \frown\!\!\smile$ L, or ω L, where ω is the angular velocity—the name *reactance* has been given by the American Institute of Electrical Engineers, at the suggestion of Messrs. Steinmetz and Bedell, and is meeting with general acceptance. When we remember that the reactive E.M.F. is an induced pressure, and obeys the general laws of induced currents, it is easy to see that its maximum value occurs at the moment when the value of C is zero. For when C is a maximum the number of lines of force passing through the coil is a maximum, and they are at right angles to the plane of the coils, and as at this moment this corresponds to the position of the revolving coil (armature) of our ideal alternator, § 7, when in the vertical position, the rate of change in the linkages is a minimum, and the induced E.M.F. or reactive E.M.F. is zero. When, however, C is zero (and this occurs when the revolving coil of the ideal alternator is at right angles to the vertical position), the rate of change in the number of linkages in the coil is a maximum, so that in all cases the reactive E.M.F. follows the current, producing the inductance at right angles. If these results be represented graphically, the reactive E.M.F. must be plotted in a direction at right angles to the current, of which it is a function. Thus we see that the reactive E.M.F., in overcoming the resistance of the coil, absorbs no power for it acts at right angles to the current, and is quite distinct from that component of the impressed E.M.F. which overcomes the ordinary resistance of the rest of the circuit. It is plain, then, that the impressed E.M.F. is the sum of two component E.M.F.'s, but since their directions are not coincident—one being in quadrature with the other—the geometrical and not the arithmetical sum is taken. This is shown graphically as follows, the problem being a simple exercise in compounding two forces at right angles to one another:

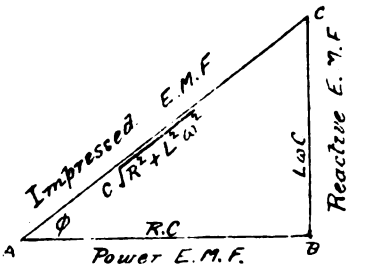

Fig. 9.

In Fig. 9 the E.M.F. overcoming the resistance of the circuit is denoted by the horizontal line A B, and is termed the power E.M.F., since this resistance consumes power, and the other component, the reactive E.M.F., is denoted by B C at right angles to A B. To compound these two forces the extremities A and C are joined by the line A C, which denotes the impressed E.M.F. in magnitude and direction. Hence

Impressed E.M.F.

$$= \sqrt{(\text{power E.M.F.})^2 + (\text{reactive E.M.F.})^2} \quad (1)$$

This expressed in symbols is

$$E^2 = (R\,C)^2 + (L\,\omega\,C)^2 = C^2\,[R^2 + L^2\,\omega^2],$$

$$\therefore E = C\sqrt{R^2 + L^2\omega^2} \quad . \quad . \quad . \quad . \quad (2)$$

where $\omega = 2\pi \frown\!\!\smile$, or $2\pi/T$, T being the periodic time of a cycle.

From (2) we get the value of the current, thus

$$C = \frac{E}{\sqrt{R^2 + L^2\,\omega^2}} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

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This is the general form of the equation, corresponding to Ohm's law, and may, in fact, be called Ohm's law for alternating currents. In such cases C and E are virtual amperes and virtual volts respectively.

§ 15. **Angle of Lag.**—It will be noticed from the above figure that the power E.M.F. makes an angle ϕ with the impressed E.M.F., and since the current flowing through the circuit coincides in direction with the power E.M.F., it is evident that the current *lags behind* the impressed E.M.F., and the angle B A C, or ϕ, is termed the *angle of lag*. The tangent of this angle, or tan ϕ, measures the *retardation of phase*, and it may be mentioned here that ϕ can never exceed 90deg. From Fig. 9 we see that

$$\tan\phi = \frac{L\omega}{R} = \omega\frac{L}{R} = \omega \times \text{time constant (see § 6)},$$

an expression which emphasises the facts mentioned in § 6.

By noting that $C = \frac{E}{R}$, when self-induction is absent in a circuit, it is obvious that the effects of self-induction are twofold—*i.e.*, (1) a retardation of phase in the undulations of the current, and (2) the current strength is diminished in the ratio of R to $\sqrt{R^2 + L^2\omega^2}$—that is, as if the resistance had increased in the ratio of $\sqrt{R^2 + L^2\omega^2}$ to R.

It should be noticed that ω—angular velocity—depends upon the speed, and, in consequence, self-induction is a more important factor than the resistance at high speeds. This is clear from the following simple exercise. A circuit has a resistance of 50 ohms and an inductance of 0·5 henry, then if the frequency is 100, $\sqrt{R^2+L^2\omega^2} = \sqrt{(50)^2 + (2\pi \times 100 \times \cdot 5)^2} = 316\cdot5 = 6 \times R$.

Maxwell has expressed the fact that a retardation of phase is due to self-induction in circuits through which periodic current flow, by writing the instantaneous value of the current as follows:

$$C = \frac{D \sin(\theta - \phi)}{\sqrt{R^2 + L^2\omega^2}} \quad \ldots \quad (4)$$

which expresses *Maxwell's law* algebraically. θ is the angle through which the armature of the alternator has turned from its vertical position in the time under consideration, and ϕ is the angle of lag due to self-inductance, whilst $\sqrt{R^2 + L^2\omega^2}$ indicates the cause of the diminution of the current strength. For practical purposes, however, the form given in equation (3) § 14 is the most convenient, since the ammeter and voltmeter gives the actual values of C and E.

§ 16. **Impedance.**—The denominator—$\sqrt{R^2+L^2\omega^2}$—in equations (3) and (4) is a quantity which in Ohm's law for alternating currents takes the place of the resistance of the circuit, and is measured in ohms. It has been termed "virtual resistance," in conjunction with the terms "virtual volts" and "virtual amperes"; but its generally accepted name is *impedance*, a term which was first introduced by Mr. Oliver Heaviside, and finally adopted by the British Association Committee on Electrical Standards at the Newcastle meeting, 1889, in preference to the term *résistance apparante* adopted at the Paris Congress the same year. The above committee define *impedance as the ratio of the effective E.M.F. to the effective current.* Considered by itself, impedance is the sum of every form of obstruction—such as dissipative resistance, reactance, and condensation (which will be considered in our next)—met with in alternating-current circuits. Seeing that impedance is measured in ohms, it is not advisable to term dissipative resistance ohmic resistance, as is frequently done. Since impedance is the square root of the sum of two squares, or

$$(\text{Impedance})^2 = (\text{resistance})^2 + (\text{reactance})^2,$$

impedance may be graphically represented by the hypotenuse of a right-angled triangle, as in Fig. 10, in which the sides A B and B C = R and L ω respectively. In the triangle A B C, Fig. 9, giving the E.M.F.'s, it will be noticed that C is a common factor in each expression, so that Fig. 10 is the previous figure modified, and is useful in determining impedance and angle of lag from the quantities R, L, and ω. The method of applying the above principles in practice is shown in the following solution of an example given at the City and Guilds Institute examination in 1892.

Example.—If with 120 alternating volts having a frequency of 70 periods per second, there is produced in a circuit of four ohms an alternating current of 24 amperes, what is the coefficient of self-induction, and the angle of lag of the current?

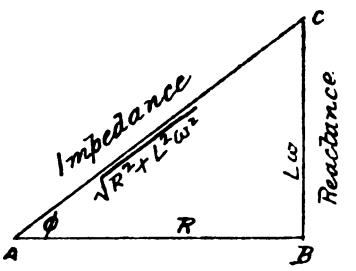

Fig. 10.

(1) Determination of L, the coefficient of self-induction. Substituting the given values in the equation,

$$C = \frac{E}{\sqrt{R^2 + L^2\omega^2}},$$

we get

$$24 \text{ amperes} = \frac{120 \text{ volts}}{\sqrt{(4)^2 + (2 \times \frac{22}{7} \times 70 \times L)^2}} = \frac{120}{\sqrt{16 + (440L)^2}}.$$

$$\therefore \sqrt{16 + (440\,L)^2} = \frac{120}{24} = 5,$$

or, $$(440\,L)^2 = 25 - 16 = 9.$$

$$\therefore 440\,L = 3,$$

and $$L = \frac{3}{440} = 0{\cdot}00682 \text{ henry}.$$

(2) Determination of ϕ, the angle of lag.

$$\text{Since } \tan\phi = \frac{L\omega}{R} = \frac{2.\pi \frown L}{R} = 2 \times \frac{22}{7} \times 70 \times \frac{3}{440} \times \tfrac{1}{4}$$
$$= \cdot 75;$$

$\therefore \phi = 36°\ 52'$ or 37° (approx.) from tables of tangents.

§ 17. **Curves Showing Lag.**—It is very interesting and instructive to show the retardation of phase due to inductance in a circuit by means of a set of curves as in Fig. 11.

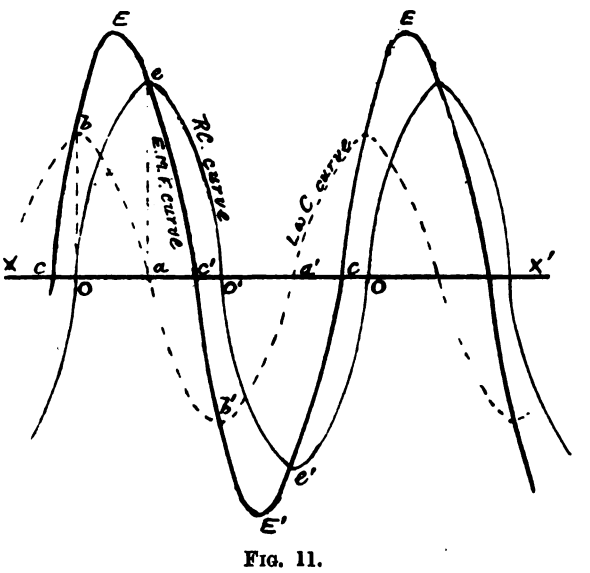

Fig. 11.

To further make the example instructive, we shall represent graphically the example just considered numerically. If the self-induction were absent, then the pressure required to drive 24 amperes through the four ohms resistance is found as follows: E = C × R = 24 × 4 = 96 volts = power E.M.F. In the figure the curve O e O' e' O represents this

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E.M.F., and is drawn to scale, the ordinate $a\,e$ denoting 96. Since inductance is present, the E.M.F. of self-induction is $L\,\omega\,C = 2 \times \frac{22}{7} \times 70 \times \frac{3}{440} \times 24 = 72$ volts, and as this reactive E.M.F. is in quadrature with the power E.M.F. its maximum value occurs when the power E.M.F. is zero, and the ordinate O b is drawn to the same scale as before, from O equal to 72, and the curve $b\,a\,b'\,a'$ represents the pressure overcoming the reactance. To get the impressed E.M.F. curve, the ordinates of the two curves—the power E.M.F. curve and the reactive E.M.F. curve—for the same points on the line $x\,x'$ are added, and we get the curve $c\,E\,c'\,E'\,c$, and the set of curves thus drawn depict the facts in the preceding paragraphs.

RESONANCE IN TRANSFORMER CIRCUITS.*

BY FREDERICK BEDELL AND ALBERT C. CREHORE.

The reactive action of a condenser in an alternating-current circuit produces effects of theoretical interest and practical importance. The resultant observed phenomena under different conditions of operation are many and various; but under whatever particular sets of conditions the condenser is used the effects produced are closely correlated, and may be grouped together in one class. Electrical resonance is one of the striking phenomena of this class. In a single circuit resonance is obtained when, inductance and capacity being present, the resultant reactance is zero—that is, the reactance of the condenser is exactly equal and opposite to the reactance due to self-induction. The natural period of the circuit then equals the period of the impressed E.M.F. Complete resonance is thus obtained only when the impressed E.M.F. varies harmonically.

Effects corresponding to resonance in a single circuit may be produced by the reactive influence of one circuit upon another, occasioned by the mutual induction of the two circuits. Such effects have been discussed by Dr. M. I. Pupin, who treats the case of a transformer containing a condenser in the secondary circuit; to this class of phenomena he gives the name "electrical consonance." Additional discussion of the same subject has been given by Mr. C. P. Steinmetz.

Resonance, in this case, occurs when the relation between the primary and secondary is such that the apparent reactance of the primary circuit is zero. The elastic influence of the condenser is transferred from one circuit to the other on account of their mutual relationship, and the natural period of the primary circuit depends not only upon the value of its own constants, but upon those of the secondary as well. There is a surging of energy back and forth between the primary circuit and the secondary condenser, by intervention of their common magnetic field: the period of these surgings determines the period of the system. A condenser in either primary or secondary circuit may give rise to such oscillations.

In the general sense of resonance, the case here described would be a particular case, but for distinction we may apply the term "simple resonance" to the phenomena observed in a single circuit, the term "consonance," suggested by Dr. Pupin, being used when the resonant action is transferred from one circuit to another by the mutually inductive influence between them.

The conditions necessary for consonance, although not so simple as those for simple resonance, are definite, and may be readily determined. These are in part discussed in the papers already referred to. We have had occasion to investigate the action of condensers with transformers, and to develop their general theory, interpreting the results both analytically and graphically. The application of this general treatment to the case of resonance or consonance throws light upon the nature of the phenomena, and brings out certain important relations. With these results many of the conclusions of Dr. Pupin agree, but not so some of his deductions, particularly the statement of the conditions under which consonance occurs—namely, when the apparent impedance of the primary circuit is either a maximum or a minimum. To make our discussion complete, we may be pardoned, therefore, if we touch upon some ground in part covered before.

Problems of this nature are usually capable of two essentially different modes of treatment, leading to identical results: first, the general analytical treatment; second, the synthetical graphical treatment. Which to use is a matter of preference. It is a choice of which way to go around a block; one way or the other may be shorter, but the same point is reached by either route. These methods are well illustrated in the present instance. In the study of resonance and consonance the graphical method is the more direct. It is replete with obvious conclusions, and at once brings out relations not simply shown by analytics.

After a brief analytical treatment we will pass to the graphical.

Analytical Treatment.

Let us use the following notation:

I_1 = primary current.
R_1 = resistance of the primary circuit.
L_1 = self-induction of the primary circuit.
C_1 = capacity of the primary circuit.
K_1 = reactance of the primary circuit.
J_1 = impedance of the primary circuit.

Let I_2, R_2, L_2, C_2, K_2, and J_2 represent the corresponding quantities for the secondary circuit, within and without the transformer.

E = harmonic E.M.F. supplied to the primary circuit.
ϕ = angle of phase difference between primary E.M.F. and current.
M = coefficient of mutual induction between the primary and secondary circuits.
$\omega = 2\pi \times$ frequency.

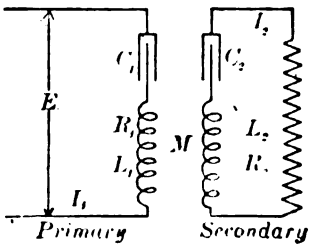

FIG. 1.—Arrangements of Circuits.

Let R_1', L_1', K_1', and J_1' represent the apparent values of the quantities indicated.

It is to be noted that

$$\text{reactance} = K = \omega L - \frac{1}{C\,\omega};$$

$$\text{impedance} = J = \sqrt{R^2 + K^2};$$

$$\text{apparent impedance} = J_1' = \sqrt{R_1'^2 + K_1'^2}.$$

on account of which OB would be little more than 90deg. behind OA.

The vector sum of the active E.M.F., OH, and the reactive E.M.F., HT, determines OT, the E.M.F. to overcome the impedance proper of the primary. The impressed E.M.F., OF, is the sum of OT, and the back E.M.F., TF.

Under the assumption that I_1 is constant, evidently OB is constant. As the secondary capacity or reactance is varied, the point D moves on the circle ODB, and the point F moves similarly on the circle TQFPG. This determines the phase of the primary E.M.F., OF, which may be either in advance of the current or behind it, being in phase with it at two points, P and Q. In the case represented in the figure, the E.M.F. is behind the current.

The line, TF, showing the back E.M.F. due to the secondary current, may be resolved into

$$\text{the active E.M.F. } TW = TF \cos\theta_2 = \left(\frac{M\,\omega}{J_2}\right)^2 R_2\,I_1;$$

$$\text{the reactive E.M.F. } WF = TF \sin\theta_2 = \left(\frac{M\,\omega}{J_2}\right)^2 K_2\,I_1.$$

These are the components of the back E.M.F. Adding these to OH and to HT respectively, we obtain the total values of the active and reactive E.M.F. in the primary—viz.:

$$OZ = R_1 I_1 + \gamma^2 R_2 I_1 = R_1' I_1;$$
$$ZF = K_1 I_1 - \gamma^2 K_2 I_1 = K_1' I_1.$$

* From the *Physical Review*, New York.

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The diameter of this primary circle is the value of TF, when in the position TG, which occurs when K = 0. The secondary current is then in the direction of OB, and we have $I_2 = M\omega I_1 \div R_2$. The diameter of the primary circle is then

$$M\omega I_2 = M\omega \frac{M\omega I_1}{R_2}.$$

A primary condenser changes the length of HT, the point T moving towards H, as the condenser reactance is increased; in fact, it may be moved to the right of H. For a case in which the primary reactance is due to inductance alone, the diagram as drawn applies.

With the secondary condenser removed, the point F would move to some point as Y, and the point D to a corresponding point, Y', depending upon the resistance in the secondary circuit, and upon the amount of magnetic leakage, a small amount of which is here assumed present. The limiting positions therefore of the point F are Y and T. As TY would be the position of TF in the absence of the secondary condenser, it follows that a line drawn from Y to F in any position shows the component of the primary E.M.F. due to the secondary condenser. The point F could not lie on the dotted portion of the curve.

If we divide the E.M.F. diagram, Fig. 2, by the value of the primary current for which it was constructed, we obtain (Fig. 3) an impedance diagram, independent of current or E.M.F. Here OH represents ohmic resistance [or a power coefficient where other losses are involved]; HT is the primary reactance; OT is the primary impedance. The apparent primary impedance, OF, is the sum of the impedance OT and of TF, an impedance component due to the reaction of the secondary; of this, YF is due to the presence of the secondary condenser.

From Fig. 3 we have

$$OZ = R_1' = R_1 + \gamma^2 R_2;$$
$$ZF = K_1' = K_1 - \gamma^2 K_2;$$
$$OF = J_1' = \sqrt{R_1'^2 + K_1'^2}.$$

For the case in which the secondary alone contains a condenser,

$$\frac{1}{C_1\omega} = 0 \text{ and } K_1 = L_1\omega.$$

For the general case, in which we suppose that condensers with capacities C_1 and C_2 are located in the primary and secondary circuit respectively, as shown in Fig. 1, we have the solution for the primary current—

$$i_1 = I_1 \sin(\omega t + \phi),$$

where
$$I_1 = \frac{E J_2}{\sqrt{a^2 + b^2}},$$

and
$$\phi = -\arctan\frac{b}{a} + \arctan\frac{K_2}{R_2},$$

$$\tan\phi = \frac{-\frac{b}{a} + \frac{K_2}{R_2}}{1 + \frac{b}{a}\cdot\frac{K_2}{R_2}} = -\frac{b R_2 - a K_2}{a R_2 + b K_2}.$$

Here a and b are abbreviations which, in this general case, have the values—

$$a = -\omega^2 (L_1 L_2 - M^2) + \left(\frac{L_1}{C_2} + \frac{L_2}{C_1} + R_1 R_2\right) - \frac{1}{C_1 C_2 \omega^2},$$

$$b = \omega (R_1 L_2 + R_2 L_1) - \left(\frac{R_1}{C_2\omega} + \frac{R_2}{C_1\omega}\right);$$

or, $a = R_1 R_2 - K_1 K_2 + M^2\omega^2$,

$b = R_1 K_2 + R_2 K_1$.

Substituting these values of a and b, we obtain

$$\tan\phi = -\frac{R_2^2 K_1 + K_1 K_2^2 - M^2\omega^2 K^2}{R_1 R_2^2 + R_1 K_2^2 + M^2\omega^2 R}.$$

By rearrangement we obtain our results in the following useful form:

$$\tan\phi = -\frac{K_1 - \gamma^2 K_2}{R_1 + \gamma^2 R_2} = -\frac{K_1'}{R_1'};$$

and
$$I_1 = \frac{E}{\sqrt{(R_1 + \gamma^2 R_2)^2 + (K_1 - \gamma^2 K_2)^2}} = \frac{E}{J_1};$$

where
$$\gamma = \frac{M\omega}{J_2} = \frac{I_2}{I_1}.$$

We thus have for the primary circuit—

apparent resistance $= R_1' = R_1 + \gamma^2 R_2$;
apparent reactance $= K_1' = K_1 - \gamma^2 K_2$;
apparent impedance $= J_1' = \sqrt{R_1'^2 + K_1'^2}$.

The apparent primary reactance equals the real reactance diminished by a multiple of the secondary reactance. The apparent primary resistance equals the real resistance increased by the same multiple of the secondary resistance. This multiple is the square of the ratio of secondary and primary currents.

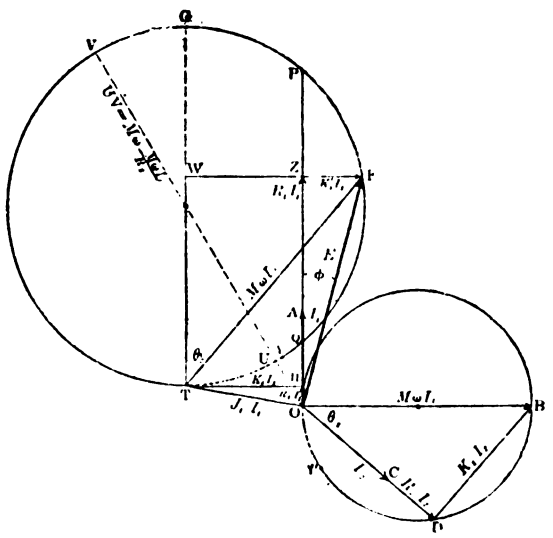


FIG. 2.—Impedance Diagram. Positive Rotation is Counter-clockwise

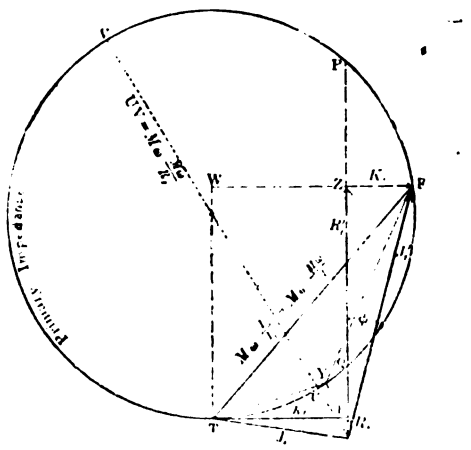
For completeness we may add

$$i_2 = I_2 \sin(\omega t - \phi - 90\text{deg.} - \theta_2),$$

where
$$I_2 = \frac{M\omega I_1}{J_2},$$

and
$$\tan\theta_2 = \frac{K_2}{R_2}.$$

These results are independent of any assumption concerning magnetic leakage. They are rigorously correct when the capacities and coefficients of induction are constant, and the impressed E.M.F. is harmonic. Where the E.M.F. is not harmonic, the solution may be applied to each component of the complex wave; or we may make use of the idea of an equivalent sine wave, which, although useful, and in many cases capable of giving approximately correct results, is not rigorous for this case.



3. Impedance Diagram (obtained by dividing E.M.F. Diagram, Fig. 2, by I

The conditions for consonance are readily obtained by noting the conditions under which the apparent reactance of the primary is zero. These will be discussed after the graphical treatment of the problem, from which these results analytically obtained are independently derived from geometrical considerations.

GRAPHICAL TREATMENT.

In the graphical treatment of resonant phenomena, or of any alternating-current problem, there are four correlated

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methods of representation. We may plot E.M.F.'s, as in Fig. 2; impedances, as in Fig. 3, obtained by dividing our E.M.F. diagram by current; admittances, as in Fig. 4, the reciprocal of our impedance diagram; and currents, as in Fig. 5, obtained by multiplying the admittance diagram by an E.M.F. Figs. 4 and 5 are reciprocal to Figs. 2 and 3. There is a close relation between all of these diagrams. We will build up Fig. 2, step by step, and discuss it in detail; the full discussion of the other diagrams will scarcely be called for. Our particular study is to determine the action of the condenser in the secondary circuit.

In Fig. 2, let OA = I_1 represent the primary current, which for the present is assumed constant; OB = $M \omega I_1$, drawn 90deg. behind OA, represents the E.M.F. induced in the secondary by the primary current, the instantaneous value of this E.M.F. being $M \frac{di_1}{dt}$. Positive direction of rotation is taken as counter-clockwise.

The secondary current, OC, lags behind OB by an angle θ_2, whose tangent is $K_2 \div R_2$. The primary impressed E.M.F., E, is the sum of three components: OH = $R_1 I_1$, to overcome primary resistance; HT = $K_1 I_1$, to overcome the reactance of the primary circuit; and TF = $M \omega I_2$, to overcome the back E.M.F. induced in the primary by the secondary current. These components are in the direction of the primary current, and at right angles to the primary and secondary currents respectively. When iron is present, R_1 is strictly a power coefficient, hysteretic and ohmic; OH is the power E.M.F. for all expenditure of power excepting in the secondary. Eddy currents and hysteresis are thus taken into consideration, in so far as they occasion an expenditure of energy. Hysteresis would likewise cause a lagging of magnetisation behind the magnetising current.

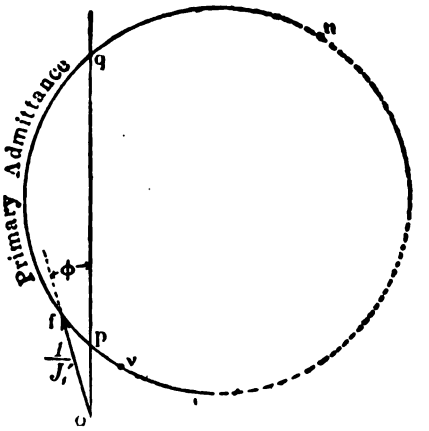

FIG —Admittance Diagram (the Reciprocal of the Impedance Diagram).

From Fig. 2 we also have

$$E = I_1 \sqrt{R_1'^2 + K_1'^2} = I_1 \sqrt{(R_1 + \gamma^2 R_2)^2 + (K_1 - \gamma^2 K_2)^2}.$$

We have thus obtained by geometrical methods the results derived above by analytical processes. In Fig. 3, for the maximum and minimum values of the apparent impedance, we have OV and OU; for consonance we have the values OQ and OP. We may note that while for consonance the secondary condenser decreases the apparent reactance of the primary to zero, it gives rise to a corresponding increase in the apparent resistance.

If, in Fig. 3, OF is a vector representing the apparent impedance of the primary, we may obtain the value of the admittance by taking the reciprocal of OF. Now OF is a vector drawn from the origin O, and lies on the circle TQFPG as the secondary reactance is changed. By the principle of reciprocal vectors it follows that, if the locus of the impedance vector is a circle, the locus of the admittance vector (its reciprocal) will likewise be a circle. In Fig. 4, *of* is a vector representing admittance, being always equal to the reciprocal of OF, Fig. 3. The circle *vpfqu* in Fig. 4 is reciprocal to the circle VPFQU in Fig. 3. We may note the reciprocal points *u*, *v*, *p*, *q*, and U, V, P, Q. The points of minimum and maximum impedance U and V correspond to the points of maximum and minimum admittance *u* and *v*. The admittance diagram is evidently independent of current or E.M.F.

Let us now assume an alternating E.M.F., **E, constant** in value, supplied to the primary circuit. **Multiplying** our admittance diagram (which for simplicity is **not complete**) by E, we obtain the current diagram, Fig. 5. **Here** *oh* is the power current in the direction of the **E.M.F.**; *ht* is the reactive current, and represents no work. **The resultant** is *ot*, the open-circuit current, which is denoted **by** I_0. It is to be observed that *oh* is the current representing **the power** expended in all ways other than in the **secondary** circuit. The actual current, I_1, which flows in the **primary** when the secondary is closed, is the resultant of the **open-circuit** current, *ot*, and the component, *tf*, due to the **reaction** of the secondary, which is equal to the **secondary current** multiplied by the ratio of secondary to **primary turns** ($S_2 \div S_1$).

As the secondary reactance is varied, the **primary current** changes in magnitude and direction **according to the** reaction of the secondary, as lies upon the circle, **as shown**, as a locus. The dotted portion of the circle **corresponds to** the dotted portion in the previous figures. **This diagram** corresponds to that of Mr. Steinmetz.

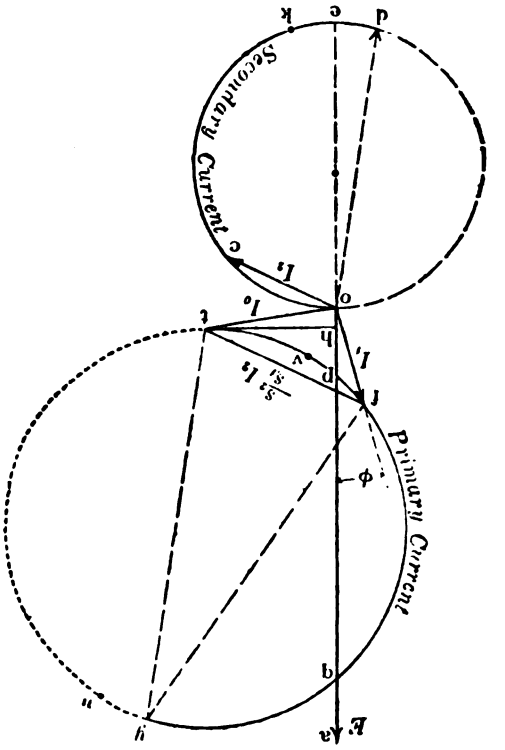

FIG. 5.—Current Diagram Admittance Diagram Multiplied by Primary E.M.F., E).

The points of consonance, *p* and *q*, correspond to P and Q above. If consonance can be obtained at all, there are two values of the primary current for which it may be obtained.

The secondary current, I_2, varies proportionally to *tf*, and is drawn as *oc*, with its locus on the circle *cked*. In the present case (which assumes a certain amount of magnetic leakage), the secondary current would take the position *od*, if the secondary condenser were removed from the circuit. It could only move on to the dotted part of the curve in case self-induction were added to the secondary circuit, or, what is the same thing, the magnetic leak increased. We thus see the action of the condenser and of magnetic leak are opposed, and that magnetic leak may be thus compensated for. In fact, the secondary circuit may be given a capacity which will over-compensate for magnetic leakage; as a constant-potential transformer is loaded the secondary E.M.F. may rise, despite the magnetic leakage drop and the fall in potential due to ohmic resistance. In the absence of condenser, magnetic leak, and open-circuit losses—that is, if *oh* were zero—the secondary current would be in the direction *oe*. Losses on open circuit, eddy currents, hysteresis, etc., give to the open-circuit current the power component *oh*, and in the absence of magnetic leak the secondary current would assume the position *ok*.

In the present instance the point of minimum impedance,

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U, and maximum current, u, are on the dotted portion of their respective circles, and so could not be actually obtained. This, however, is not necessarily so. By the principle of reciprocal points it follows that the product of the maximum and minimum currents is equal to the product of the two consonant values of current—that is,

$$ou \times ov = op \times oq.$$

We may best examine the conditions of consonance by returning to Fig. 2. When the primary circle does not intersect OP there can be no consonance. Analytically we would obtain imaginary values. If there is one condition for consonance there must be two, corresponding to the points P and Q, except in the limiting case, when the circle is tangent to OP. Then HT would equal the radius of the circle, and

$$K_1 I_1 = \frac{M \omega}{2} \frac{M \omega I_1}{R_2}.$$

For consonance to be possible, we must therefore have the relation

$$M^2 \omega^2 > 2 K_1 R_2.$$

The points of consonance are determined by equating the value of primary apparent reactance to zero ; thus

$$K_1' = K_1 - \gamma^2 K_2 = 0 ;$$

or

$$\frac{K_1}{K_2} = \frac{M^2 \omega^2}{R_2^2 + K_2^2}.$$

Two values of K_2 will satisfy this condition. Frequency is an important factor in this criterion. The conditions for consonance are obtained when OD is perpendicular to TQ or to TP.

A particular case, which may be termed "pure consonance," is obtained when the natural period of each circuit independently is equal to the period of the impressed E.M.F. The period of the system in this case is evidently the same as the period of either circuit. We have K_1 and K_2 each equal to zero. The point T coincides with H, and OD takes the position OB.

We have seen that all our conclusions concerning consonance may be obtained independently by analytical or by graphical methods, the results by the two methods being easily identified. The graphical method, however, appeals to us as the more evident.

Although it is readily shown that the loci of primary impedance and admittance are circles, as the secondary reactance is changed, the conditions are not easily obtainable for a wide range of variation. The diagrams here drawn are for an assumed case, and the secondary capacity is varied from zero to infinity. Ordinarily, the range of variation would be small, as Dr. Pupin has pointed out, and as has been the result of our own experiments. It is to be hoped that Dr. Pupin, who has experimented so faithfully on simple resonance, will bring out equally valuable results from his experiments in electrical consonance.

In addition to the effect of consonance, the action of a condenser to counterbalance leakage has been pointed out above. Although scarcely germane to the present discussion, we may call attention to another effect which may be produced by means of a properly proportioned condenser in the secondary circuit. If the secondary reactance be made zero (inside and out of the transformer), simple secondary resonance is obtained, and a constant primary current will transform to a constant secondary E.M.F.

PRESENT RANGE AND ACCURACY IN THE MEASUREMENT OF ELECTRICAL RESISTANCE.*

BY HERSCHEL C. PARKER.

The measurement of electrical resistance may justly claim one of the foremost positions among physical determinations for range and for accuracy. The limits from theoretical and practical considerations we may place at one ten-millionth of an ohm (1×10^{-7}) for the lower, and ten million million ohms (1×10^{13} or 1×10^{7} Ω) for the higher—that is, a range from one to one hundred million million million (1 to 1×10^{20}). It should be remembered that this scale is uniform throughout, measurements being easily made in all parts of it with an accuracy varying from 1 per cent. to ·01 per cent. Difficulty only is encountered at the extreme limits. The lower limit is determined by the sensitiveness of the galvanometer and the current available. The higher, also by the sensitiveness of the galvanometer, the E.M.F. used, and the insulation of the instruments.

A few comparisons with other physical magnitudes may, perhaps, prove interesting. The wave length of sodium light is $5{\cdot}9 \times 10^{-7}$ metres. The distance from the earth to the sun is $1{\cdot}5 \times 10^{11}$ metres. The ratio is 1 to $2{\cdot}5 \times 10^{17}$. Hence the ratio of 1 to 10^{20} is the same as that of the sodium wave length to 400 times the distance from the earth to the sun. That is, from ·00059mm. to a distance that would require more than two days for light to travel. Again, taking a copper bar, the area of the cross-section being equal to 1·6 square centimetres, we may measure the resistance of a length from 1mm. to 10^{17} metres. A distance requiring about 10 years for radiant energy to traverse, moving with the velocity of light.

In the determination of mass a parallel case would be from 0·00001 gramme (shown by the most sensitive balance) to 10^{12} kilogrammes (equal to about one billion tons. The ratio of one gramme to the earth's mass is 1 to 1×10^{27}. In the measurement of length the different light-waves may easily be determined and stellar distances accurately calculated ; but it would be hardly possible by laboratory methods to measure any given intermediate distance.

It may be well to outline a few of the methods used in determining electrical resistance. For resistances varying from 0·01 ohm to 1,000,000s ohm we have the universal Wheatstone bridge method. For low resistances, some method independent of leads and contacts must be employed. Hence we must use fall of potential measurements, and avoid any error which may be caused by variations of the current. This may be accomplished in the following manner : across the copper bar whose resistance is to be measured is placed a Thomson or a d'Arsonval galvanometer, and in series with the low resistance is placed an ammeter. Now, suppose the galvanometer and ammeter are read at the same time, and that a current of 10 amperes was used ; then

$$R = \frac{E}{10}.$$

The value of 1deg. on the galvanometer scale should, of course, have been previously determined in fractions of a volt. A Thomson galvanometer of 10,000 ohms resistance may have a figure of merit of 50,000 Ω. Then a deflection of 1deg. would correspond to a potential difference of ·0000002 volt across its terminals, and R would equal $\frac{\cdot 0000002}{10}$ × deflection. If a d'Arsonval galvanometer whose figure of merit was 500 Ω and resistance 500 ohms was employed, then 1deg. deflection is equal to ·000001 volt. Low resistances may also be determined very satisfactorily by the Thomson double bridge method. For very high resistances we have the usual deflection method. If a galvanometer whose figure of merit is 50,000 Ω be used and an E.M.F. of 200 volts, we obtain a constant of 10,000,000 Ω. It is hardly necessary to state, however, that the measurement is really limited by the insulation of the apparatus.

The greatest accuracy is attained in the comparison of standard ohms by Carey Foster's method. Here an agreement of results to even ·001 per cent. may be reached. For a great majority of resistance measurements an accuracy of 1 per cent. is all that is desired, even though with care a higher might be obtained. The limits of measurement that have been given above seem to be justified by the present state of the science, but it seems probable that they may be considerably advanced by the use of special methods.

* From *Electric Power*, New York.

Book Received.—Messrs. Crosby Lockwood and Son send us "Acoustics in Relation to Architecture and Building : The Laws of Sound as Applied to the Arrangement of Buildings," by Mr. T. Roger Smith.

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THE DUTIES OF THE TECHNICAL PRESS.

The policy of the large daily papers has now reached such a stage of finality that little change is to be expected in their methods of procedure. Papers of one political creed are allowed by common consent to write strong leading articles with the professed object of exposing the personal and political weaknesses of the gentlemen who hold views different from theirs. The effect, although often hard on individuals, tends to the cleansing of political life. Technical papers have few such duties to perform, but the superabundant knowledge possessed by their editorial staffs is apt to lead them astray. It would be difficult to find, say, a Liberal paper regularly exposing the weaknesses of its leader's hand. Yet we regret to acknowledge that the electrical Press is repeatedly guilty of this fault. Any information tending to correct faults found to exist in the manufacture and running of electrical plant we welcome heartily, but such fine investigations as lead to the publication of the fact that a steam joint blew in a certain station, which caused the pressure of the supply to fall half a volt below the Board of Trade requirement for one and a quarter minutes, do not further the advance of the industry of electric lighting. Other interesting details as to why the lights in the same district were extinguished for a few minutes may follow soon after the above, and in this way the general idea is spread that a certain supply company is in a bad way, whereas the company may be supplying a light far more regularly than the gas supply in many provincial towns. We say emphatically that those gentlemen who have nothing better to do than to pick holes indiscriminately in everything they come across are a curse to the profession. We require our staff to bear in mind the following outlines as to the duties of the technical Press, and hold that a uniform acceptance of the same would be beneficial—*i.e.*, that the ends for which our paper is published are to foster the industries connected with it by giving prominence to all new work successfully accomplished; to give technical information to those engaged in the profession of electrical engineering; to publish as promptly as possible the advances made in methods of increasing the utility of the profession; and to protect the untechnical public from fraudulent adventurers. These are wide-reaching requirements, and are at times given a somewhat loose construction; and, again, as in many other matters, it is easier to learn what to do from a statement of what not to do.

In this connection we agree with several prominent engineers in the profession that it is not the duty of the technical Press to chronicle the breakages of the governor belts in electric lighting stations, nor the flickering of an erring arc lamp. Mr. Preece informed us at Cheltenham that he has had some six thousand street boxes for telegraph purposes under his charge in London for years, and that explosions due to gas occur more frequently than we care to state. But he also stated that during that time no one has been in any way hurt by these explosions, as also no one has been hurt by

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the explosions in the electric lighting street boxes. He facetiously added that the horse that expired in Cannon-street died from fright. That fright has by the injudicious action of the technical Press been spread through the length and breadth of the land, and every member of electric lighting committees is anxious to know if their towns are likely to be devastated by such explosions. Provided the lids of the boxes can be lifted easily so that the force of the explosion can be easily dissipated, no harm is to be expected even should the gas get the better of the ventilating gear.

Again, it is not the duty of the technical Press to assist any budding consulting engineer in gaining notoriety by publishing the defects in the supply furnished by the leading electric lighting companies. If the gentleman doing this sort of thing had devised any means of preventing the irregularities which may exist, it would be a different matter, but otherwise the information is abortive. Further, no useful ends are attained by damning a gentleman who reads a paper before an engineering institution because the said gentleman has sufficient information by him to fill more than one paper a year. The expression of the President of the Institution of Electrical Engineers at a recent meeting on this subject has our full endorsement. It is not the duty of the technical Press to run amuck amongst those members of the profession who, perhaps, are not blessed with that superabundance of knowledge possessed by every office boy on their staffs. A want of that knowledge may lead to mistakes, but an honest endeavour to forward the industry should not be recklessly condemned. The last negative clause is perhaps as important as any two of the preceding together. A technical paper should not be bound or controlled by a clique, or by any association of contracting firms. The editors of such papers, although they may be able men, are tied hand and foot, and must give unfair prominence to certain subjects. The result is, that the general public are deceived. It is a matter of difficulty to hold the balance even without the control referred to above, but when a man has to please certain contracting firms, or a clique, in order to retain his position, his paper descends from being a technical paper into a puffing circular.

DUBLIN TRAMWAYS—OUR LEADER-WRITER'S REPLY.

Our leader of May 17 with regard to the Dublin Tramways report has drawn forth a somewhat heated letter from Mr. James L. Owen, which we printed in our last issue. We are led to understand that Mr. Owen has had an extremely wide and intimate acquaintance with electric traction, and we cannot but appreciate that his "certain knowledge" of such matters forces him to express his disagreement with us in terms which are, to say the least, discourteous.

So far as we are aware, the opinion we expressed—viz., "that economical and efficient operation can best be secured by a trolley wire over the centre of the car roof"—is most thoroughly sustained by practically all electric traction engineers, whether European or American. We would suggest that the line at South Staffordshire is by no means a thing of yesterday; that it has been visited in all probability by representatives of most of those constructing companies which are now engaged in traction work; that the methods there adopted have been given wide publicity through the technical Press and the publications of learned societies; and that, notwithstanding these facts, this method of line suspension has been followed only, to the best of our knowledge, in the Bristol line now under construction by the British Thomson-Houston, Limited, and there to only a limited extent. In that city, the authorities refusing a span wire, bracket-arm poles placed either between tracks or along one kerb have been adopted, but the desire to get car and trolley wire as near together as possible is shown by the fact that bracket arms ranging from ten to twenty feet in length will be used wherever the line is supported only from one side of the roadway.

Mr. Owen undoubtedly over-estimates the danger that lies in the possibility of span wires breaking and falling into the street. Such accidents are of the rarest. It is true that top-seat cars are not in *general* use throughout the United States, but it is also true that they are successfully employed on the Californian lines with a span-wire system of construction, and that their popularity is steadily increasing. If span-wire accidents were of the frequency which Mr. Owen's alarmist statements would indicate, the question as to whether roof seats be used on a line or not would matter little. A falling line would be quite as dangerous to the travelling public in other vehicles in the streets as to those who happened to occupy a slightly more elevated position.

We are quite willing to apologise for having wounded Mr. Owen's feelings by referring to the South Staffordshire as a "country line," and to concede that, even if the greater part of its route is along country roads, it does pass through several considerable towns. Most terms are relative in this world, and we merely desired to indicate our belief that the conditions were decidedly unlike those which would maintain in such cities as Dublin, where the most efficient service must be secured to the public. Notwithstanding the confidence with which Mr. Owen asserts that local authorities will not countenance the span wire, the fact remains that sixteen miles of tramway track are now being electrically equipped with span-wire suspension in Dublin and its suburbs.

Let it be understood that we quite appreciate the æsthetic objection to the span wire or to any wire of any nature in a city street. As we have already said, we greatly prefer the centre-pole method of suspension (which is no more obnoxious than the system of lighting from poles at refuges used in London highways) wherever there can be space enough secured between the tracks, but we certainly do not believe that the sole function of a city street is to please the æsthetic eye, and we do believe that its first use is to afford the best and most rapid method of transit, and that within reasonable limits nothing should be allowed to stand in the way of that end being attained.

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We are sorry to disagree with Mr. Owen; sorry that his experience and "certain knowledge" differs from that of possibly more prominent traction experts; sorry that our "inconsistencies" and "power of making statements which are unsupported by facts" have brought down his criticism upon us; but our sorrow is greatest that he should express himself with needless intemperance when referring to a wholly unprejudiced opinion even if it be at variance with his own.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

DUBLIN TRAMWAYS.

SIR,—Who is Mr. James L. Owen, of 120, Colmore-row, Birmingham, or am I so deficient in that little grain of faith that I am unable to recognise the high priest and apostle of electric traction when he does arrive and preaches in the wilderness that there is only *one* system of overhead traction, and of this he is the prophet?

Although recognising the great responsibility I incur in not accepting the dictum of a prophet, I desire, as a fellow-sinner, to extend my practical sympathy to you in your lost condition by adding my protest to yours—to that portion of Mr. Hammond's report which recommends the South Staffordshire system as the best.

I am, I fear, so case-hardened in my infidelity that, unlike Mr. Owen, I feel strong enough in experience as to have no intention of damning the South Staffordshire system to prove the merits of any other system. On the contrary, I desire to give all credit to those who were responsible for the South Stafford installation, and for the ingenious way in which the prejudices of the local authorities were overcome (if it was the local authorities who had to be overcome).

No doubt the case was a hard one. The tramway company was weak financially, and the local authorities knew it, and Mr. Dickenson no doubt wisely advised his company to agree to this system rather than close the lines, even if it did mean the introduction of an untried system on a doubtful principle and certain loss in mechanical efficiency. But, as you say, this case should not be put forward as a precedent. The engineer who sacrifices his principles to the whims of a local authority is lost; it is like the preamble of a Bill, so capable of proof until the sting of the clauses is felt which are more or less disastrous according to the financial constitution of the promoter and his fighting capacity.

In these days it is sad to contemplate the low estate to which the engineer has fallen since the days of Stephenson, Brunel, Bateman, and others. Now he is the peg on which a company hangs its conscience, the respectable signatory to other people's reports, the advertiser to somebody's system, who does not scruple to jeopardise the success of his works by pandering to the pet theories of ignorant councillors, and who, under the mystic raiment of a 5 per cent., covers the nakedness of the large profits of the contractors with a semblance of professional philanthropy.

I am not prepared to raise any question as to which system of overhead traction is advisable for Dublin, but I am prepared to suggest there may be cases where it might be somewhat difficult to apply the South Staffordshire trolley, especially in Sackville-street, which, for the conductor to be anywhere near the kerb, would necessitate a trolley arm 40ft. to 50ft. long.

No, Sir, the progress of electric traction in this country is considerably handicapped by the ridiculous contentions of engineers who have systems of their own to ride—and their name is legion. It is the duty and policy of the engineer to advise according to the particular conditions and requirements of the district. This principle is not going to be altered because Mr. Owen thinks the fire-escapes cannot be modernised to suit the march of progress. Leeds has the span-wire system and is proposing to extend it; Coventry, also. These towns apparently do not appear to share Mr. Owen's views. In London millions of passengers travel annually by 'bus and tram under a network of telephone wires without this suggested fear of wholesale decapitation.

Mr. Hammond's experience in the erection and working of overhead electric traction exists at present mainly in theory. It may be that with some practical experience he will change his ideas, which are as numerous as the colours assumed by the caterpillar as a protection when feeding on various shades of green. His suggested close relationship between traction and lighting is one of them, and can be considered at present as seriously as another one he suggested to the Municipal Corporations Association, that he would get over the difficulty of the overlapping load in working tramways from the central lighting station by the employment of horses during that period.

Mr. Owen should learn that the removal of the mountain depends very much on the material composing it, and mountains of ignorance and prejudice are easily converted into molehills by public requirements and the common-sense advice of the engineer who has no system to ride.—Yours, etc.,

STEPHEN SELLON.

ELECTRIC LIGHTING OF TRAINS.

SIR,—Referring to the article on p. 586 of your last number, I beg to point out that it was in November, 1883—not November, 1884, as stated—a District train was fitted with the electric light, and that the experimental running in public took place in January and February, 1884. The engine, "as used with a Siemens dynamo in 1881," was *not* a central-valve engine (as the writer of your article was assured by Mr. Crompton), and the date should be 1883-4. I recommended the use of an engine and dynamo fixed on the locomotive, but the whole of the motive power and gear were placed in a guard's van in order that the company might obtain full particulars of working cost.—Yours, etc.,

W. H. MASSEY.

25, Queen Anne's-gate, S.W., May 28, 1895.

P.S.—I note on p. 595, in your report of the discussion on Mr. Robinson's paper, that Mr. Crompton bought his first Willans engine 19 years ago. It would be interesting to have the exact date, and to know what the engine has been used for. I remember trying a Willans engine coupled to a Weston dynamo which I took to Thames Ditton in 1882—only 13 years ago, and I had tried several of these engines for other purposes more than 20 years ago, but I cannot trace the engine mentioned by Mr. Crompton. The four 50-h.p. sets were supplied by Messrs. Willans and Robinson to Buckingham Palace in 1884, being some of their earliest electric light engines.

OPPORTUNITIES IN ELECTRICAL ENGINEERING.*

BY A. A. ATKINSON.

(Concluded from page 601.)

There has been a great deal said by way of discussion as to whether it will be most in accord with the fitness of things to educate the student along broad and general lines as a basis, and allow him afterwards to specialise in any direction he may wish, or to train him directly in the applications with which he must have to do, only giving him enough of the technicalities to serve as a basis for future work in case he should have the opportunity or inclination to pursue such a course. These may properly be classed as technical and practical courses. In other words, I shall call technical that course of study in which are included a rigid course in higher mathematics, advanced mathematical physics, the higher mathematical theory of electricity, and much mechanical engineering. These fill up most of the first three years of the course. The fourth is devoted to laboratory work in measurements, dynamo tests, engine tests, lectures on the telegraph, turbines, heat engines, and finally a thesis. The entrance to such a course generally requires of the student qualifications such as would admit him to the

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freshman classes in any literary or scientific course. On the other hand, I shall call practical that course of training in which the mathematics, physics, chemistry, and mechanical training all look toward the engineer in practice, and which includes such parts as will be directly available for him in his everyday work, leaving the refinements for his own individual filling in afterwards, instead of teaching him the refinements and sending him out to fit some of it, if he can, to whatever application he may.

By way of further suggestion of the distinction from the purely technical, let me say that the practical course will include lectures and practice in wiring for the various kinds of distribution for lighting and power; calculations for alternating and direct current wiring under various conditions; the theory and application of electricity for railways, stationary power, lighting purposes, including the modern types of machines—direct, alternating, and polyphase; designing and calculations for the winding of dynamos and motors; theory of steam, with practical instruction in the care and operation of boilers and engines, dynamos and motors. His knowledge of lighting and power distribution will be enlarged by model plans and specifications drawn up by him to meet certain requirements in railway and central and isolated station work. More and more detail will be required in this as the student progresses, until he is able to draw and specify for actual work. We could go on further in contrasting the two lines of study, but it will be apparent to almost anyone stopping to give the matter any consideration what their distinctive features must be. The one a very general basis upon which any application may be built by a sort of second experimental training, while the other is intensely practical in all its aims and work. The one may develop the theorist, the electrical investigator, the electrician; but even here real practice in the bone labour of the profession would be of much benefit. The other will produce the artisan, the superintendent, the installing and consulting engineer. So that, assuming in both cases that the student has been apprised of the difficulties and necessities—in short, the real situation confronting him—in order he may not go out with puffed or false ideas, each course prepares for a different line of work. Of course, the one line may develop afterwards into the other.

The question now is, with conditions as they are, which offers the most to the young man? So far as it can be seen at present, considering the number of positions open, the practically educated young man has the advantage, though if the technical graduate be willing to begin low in order to learn the practical elements of the business and to convince his employer of his superior ability and skilfulness, he will find plenty of opportunities for promotion; he can then leave the lower position to another beginner. But unless he be willing to do this, the practical man, who is in a sense previously prepared for work in any application, has much the advantage. Besides, he knows the practicalities, the other has them yet to learn.

I believe the day is past when we should expect new and wide applications to develop suddenly to require the services of a number of men; the surprises in lighting and power transportation are not in the future. When these things were new, men not educated had to fill the positions; horse-drivers became motormen, fire-stokers station men, and steam engineers "electricians." Now, as these industries widen, and that rapidly, the great problems are a more efficient service, stricter economy in all directions, and a gradual weeding out of the undesirable, thus making room for those prepared to render the best service. Necessarily, this process has been slow for several reasons, but now that the various departments of the electrical business have become permanently established, this will be more rapid. The bad wiring, the wretched installation, the miserable economy of operation which have prevailed in the majority of cases in light and power plants for small towns, and also in very many not so small, will gradually disappear, because the services of trained men are beginning to be appreciated and sought. For the same reasons new installations will be manned by those who are prepared for the work.

* From *Electricity*, New York.

I can probably best indicate the situation to the electrical student by outlining the kinds of positions that may be open to him. So not by any means including all, but serving as a broad basis of division, let us lay down the following: (1) original investigation and invention; (2) consulting and constructing engineer; (3) superintendents of light and power plants, including isolated and central-station work, stationary power, railways, mining, etc.; (5) artisans in light and power; (6) artisans in factories. Those belonging in the first class I shall call electricians; those in the second, third, and fourth classes may properly be denominated electrical engineers. To be sure this is not meant to consider those cases where some member or stockholder of the company is made "superintendent" whether there is an engineer besides him or not. If he has not the electrical knowledge, and does not actually superintend the electrical part of the work, his title is a misnomer. Properly, in small towns where this is done, he should be superintendent or business manager of the "company," and not of the plant or works. It will be quite evident also that the station man in a small plant who also looks after the wiring and general repairs, is not entitled to the distinction of electrical engineer. He is merely an artisan, and the plant and town are without an engineer.

I assume in this connection that only he who has practically passed through the preceding steps and has arrived at the point of being the real superintendent of all the construction and repair of electrical appliances, whose theory and practice and experience entitle him to this distinction, shall be called electrical engineer in the sense in which I am using the title. Under (5) and (6) I mean to include all, highest to lowest, engaged in actual work in manufacturing establishments, and in the actual operation of electrical appliances in lighting and power.

As to numbers, we observe that those belonging to class (1) are comparatively few. Their preparation will be of the highest kind, technical and theoretical. The work of research must be undertaken only by those who have an intense love of truth for its own sake, and are willing to devote many weary days to its search with the expectation of no other reward than the great satisfaction of having added something to the world's knowledge. Science may indeed pause to do them tardy honour. Men of this stamp we all can name, and none are more deserving of the world's gratitude for their noble sacrifices in behalf of truth. Such men have established the laws of chemistry, physics, and electricity—indeed, have built the foundations of knowledge in all lines. They have established the bases for the modern practical applications of science, and they have invented practical devices for applying their discovered principles. They have given us the photophone, the phonograph, telephotography, the telautograph, the possibilities of electrical welding, heating, cooking, transportation, and hundreds of others. And yet their work is not done. There are the problems of light without wires, the real nature of electricity, light and power without the present wasteful methods—perhaps by maintaining very high-frequency vibrations — electrical energy directly from the sun, methods of improving the magnetic circuit of dynamos, earth telephony, etc.

Very little need be said about class (3), for the number of places is necessarily limited, being open generally only to those who have received a special training in the factory itself. New establishments select men of experience from factories elsewhere. But those who are fortunate enough to secure places as artisans are the material—some of them—out of which those more enviable men are made.

There are much greater opportunities in class (2), and these will be on the increase. As the tendencies are more and more to stricter economy, least first expense, and more efficient service in general, the electrical engineer will be more and more in demand. The time is rapidly approaching when every central station, lighting and power, and every form of electrical business will have their consulting and installing engineers. The preparation for this work must be founded in practice. Without going into detail, it is apparent that the technicalities of engineering alone will be of little avail. The reason for many failures in the successful installation and operation of electrical plants has been that the "theories" of those in charge were not

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backed up by a thorough practical knowledge and experience.

Classes (4) and (5) have the advantage of by far the greatest number of individual opportunities; and as the financial condition of the present improves this will be true in a still larger measure, since capital being less conservative will hasten to invest in the business which, when rightly managed, promises the largest per cent. on the outlay. The gradual adoption of electricity by steam roads and by new competing roads joining important centres, the rapid extension for lighting into towns everywhere, the enlarging of existing plants to meet the exacting demands for greater and better service, the extension of electric power into mines and other forms of industry—all will have the effect of opening up new and wider opportunities. But in the same proportion there will be the greater demand for more thoroughly prepared men. This needs no particular illustration; but to take a single instance, lighting, as representative of the situation in general, it has been stated on good authority that if electricity should supplant gas for lighting purposes the cities of New York and Philadelphia alone would at once require all the dynamos and lamps now in use in all the United States. I believe this is what we are gradually but surely coming to. With the inevitably cheaper production and more satisfactory results gas must die hard after a severe struggle, the Welsbach with its other devices. It can readily be seen what the advantages of electricity are, and the people will demand and get it. It needs no argument that the preparation for these two classes must be a thoroughly practical one—practical in the sense in which I have been taking it.

Under the head of (6) comes a number of positions, though much smaller than under (4) or (5). On the whole these places are not so desirable, since the chances for advancement will be limited to very few in this line of work.

From the foregoing outline it will be apparent that the men educated along what I have called practical lines have far the better chance for promotion under the present conditions, and the places they are at once able to fill are much more numerous. The technical graduate is prepared for (1). True he may work in (2) and the rest if he first goes to work to prepare for them by practical study and experience, either in school or under private instruction, with an apprenticeship. This done, his higher instruction will be of much advantage to him. But I cannot help deprecating the tendency of our so-called technical schools in their instruction to sail off into the generalities, refinements, and abstractions to the neglect of those things which are more essential for the immediate use of the great majority of their graduates.

I wish to repeat that there are and will be opportunities abundant for those rightly educated. In numbers they compare at least very favourably with those in other professions. Students must, of course, be taught the difficulties of low salaries at first—not speaking of the many favourable exceptions to this—hard work, and perseverance. But is this any less true in most other kinds of business as a rule? One great reason for the apparent overcrowding of the electrical profession is that so many are educated for positions that do not exist instead of preparing to meet the conditions as they are.

ALTERNATING AND INTERRUPTED ELECTRIC CURRENTS.*

BY PROF. GEORGE FORBES, M.A., F.R.S., M.I.C.E.

LECTURE III.

(Concluded from page 603.)

Now, I can bring before you some other illustrations of the same sort to show you that the skin resistance may become very high indeed, and may even almost prevent an electric current from passing through a good solid conductor. This is really an explanation of the experiment which was made by Faraday so long ago, in which he had a wire going round the room and separated by a few inches where the two ends came together, into which an electrical discharge from a powerful Leyden jar was sent at the two ends, when the discharge preferred to cross the air-space rather than to travel round the copper conductor, although that was an excellent conductor. That was owing to the suddenness of the discharge, and the experiments I am going to show you are illustrative of the same fact. To show it, perhaps, in a more complete manner, I will take a copper arch (Fig. 30)—this is one of Mr. Campbell Swinton's arrange

Fig. 30.

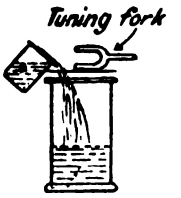

Fig. 31.

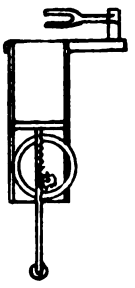
Fig. 32.

ments for which I am indebted to him—and I will send into it an oscillatory discharge. I have the means of producing very rapid oscillations in the apparatus before you. The terminals will be connected with the two ends of the arch at the base, and there is an incandescent lamp stretched across the two vertical pillars which form the sides of the arch. Any person looking at this in relation to the ordinary method of using currents would say, when we applied the current it would all flow through the thick arch and none would flow across this very high-resistance lamp; but, as a matter of fact, the resistance opposed to these very high oscillations becomes so great that it is very difficult to get the current to go up the whole length of this wire, and still more difficult to get it to go right round, and instead of going right round by that thick conductor, which would offer a certain amount of skin resistance, a great portion of the energy prefers to go across that thin filament where the skin resistance is not so predominant a feature. [*Experiment.*] At this height, you see, comparatively little of the current is able to go through the lamp. When we bring the lamp lower down, nearer to the terminals, we get more and more of the current able to pass through the conductors up to the lamp, and when we bring it down low enough we are able to get the lamp up to its full incandescence. But a mere removal is enough to prevent the current passing along the conductor sufficient to light up the lamp.

Now that I have explained to you the nature of skin resistance, and I have explained how it was produced owing to its being a solid conductor, in order to demonstrate this to you better I will now take a strip of copper instead of a piece of solid circular section. This strip of copper is of exactly the same weight per unit length, it is the same section as the wire, and it is of the same conductivity. And what I wish to show you here is that the induction of one part on another is not such a serious matter in the case of the strip, where the distances are greater than in the case of the wire, where they are all very close to the central part of the section. We will now put on the current. There, you see that the current is able to pass through the copper strip much more easily at the top than it was before. The light is very dim, but as I gradually lower the lamp, gradually there is more light. The lamp, however, is not yet at its full incandescence, and it is only when I bring it down near to the base of the arch that I am able to get sufficient current through the lamp to bring it to its full brilliancy. The difference between the copper strip and the solid copper rod is most marked.

Now, I will show you the effect with an iron rod, and in this case I have chosen an iron rod of such a section that it has exactly the same conductivity as either the copper rod which I first used or the copper strip which I used in the second place. And here the opposition to the passage of a current is very much greater than in either of the cases which we had before, as will be obvious as soon as I put the thing into action. [*Experiment.*] Gradually, as we lower it, it is coming towards its full brilliancy; but you see when the lamp reaches the same level at which in the first case it arrived at its full brilliancy, it has not arrived at its full brilliancy in this case simply for the reason that the iron between the lamp and the terminals offers such an amount of opposition that there is very little current able to pass through the lamp even at that height, and we have to lower it very low indeed before it arrives at its full brilliancy. These three experiments illustrate in an extremely good way the general character of the phenomena of skin resistance, which not only from a purely scientific point of view are of great interest, but also require careful consideration in dealing with engineering problems.

Now, passing from skin resistance, I wish to talk a little—

* Lecture delivered before the Royal Institution.

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I cannot very well show you electrical experiments, although I shall show you experiments illustrative of electrical oscillations—about the phenomena of electrical resonance, such as the rise in pressure noted some time ago on the conductors running from Deptford to London, owing to the considerable capacity of the mains used. You will see the distinction I draw between effects of resonance and oscillations. Let me introduce the subject by saying a few words about ordinary resonance. I have here a spiral spring suspended from the ceiling to which I can apply a force at regular intervals. And I will show you that when I apply a very small force to the spring at regular intervals it accumulates the energy, and eventually gives rise itself to a much greater force than that which I had been imparting to it at each individual motion. And also you will see that the velocity of motion after I have repeatedly given an impulse to the spring becomes very much greater than it would be with the same force applied at a single effort. The reason of this is that the spring is capable of oscillating in a perfectly definite period. The period of oscillation depends upon two things—it depends, first, upon the elasticity of the spring, which tends to draw it back when once it has been displaced; and, secondly, it depends upon the mass or momentum of the spring, which resist the movement. These are the only two things that come into play in this spring. There is no friction. It is not in a vessel of oil or anything of that sort which would produce friction, and the electrical analogy is simply a circuit in which there is capacity—that is, the elasticity part of it—and self-induction—that is, the momentum part of it. Just as with the mechanical spring, when we know the mass and elasticity of it we can calculate the period, so, substituting for mass and elasticity the electrical units which I have given on the table, you can calculate what the period of an electrical oscillation is also. [*Experiment.*] I exert a very slight force upon it at each stroke, and, you see, before I have taken more than two or three strokes its motion is increased to a very considerable extent. The oscillation of the spring now in its own period is very violent indeed—that is to say, the current that is flowing through that electrical system is very much greater than that which is due to the E.M.F. That is the real interpretation of the increased velocity of the spring.

I will now give you another illustration of electrical resonance. I take for that purpose a jar (Fig. 31) containing a little water, and also a certain amount of air. The air is capable of vibrating, and if the length of the jar is fixed it is capable of vibrating in a perfectly definite period. When I cause a tuning-fork to vibrate, and hold it over the mouth of the jar, it sets the air at the upper part of the jar vibrating; this vibration communicates itself to the air in the lower part, and it is then reflected from the bottom just in exactly the same way as that spring was. The air at the top of the jar represents the free end, and the water being fixed corresponds to the ceiling. I will now show you that the air in the jar will resound to this tuning-fork, and greatly increase its sound. The period that it will resound depends upon the length of the column of air. [*Experiment.*]

I used then a tuning-fork of low note. Here I have one of a higher note, and you will see that this column of air will no longer resound to it, and we must find a column of air of different length which will do so. I will cause the tuning-fork to vibrate, and then get Mr. Mitchell gradually to fill up the jar with water. As the water is poured in you will find the sound gradually increases, until when we reach a certain length the resonance is complete. [*Experiment.*] Knowing the elasticity of the air, and knowing the weight of the air, we can calculate the period just the same as we can in the case of the spring, and so we can in any electrical system where we know the farads and the henrys. As in the case of the spring and the air, the period depends only on the elasticity and momentum, so in the electrical phenomenon it depends on the capacity and self-induction, and not upon the resistance. The resistance may tend to dim the resonance, but does not alter its period.

As an illustration of ordinary resonance, I will show you an apparatus (Fig. 32) which I got out some time ago for measuring the amount of firedamp in the coal mine. It consists of a tube, whose length I can vary by means of a wheel, and tuning-fork which resounds to it. [*Experiment.*] There is no resonance now; there is now; there is none now. I pass through a maximum of resonance. I adjust the length of the tube by turning the wheel till I get the maximum, and I read by the index that there is no firedamp. The elasticity of the firedamp is the same as the elasticity of the air, but the mass that is to be moved is not so great, and therefore it will move more rapidly than with the same column of air in it.

Leaving the question of electrical resonance now, the last feature of interrupted and alternating currents which I wish to show you is oscillations. In order to illustrate the phenomena, I have prepared a model to carry out our analogies. These oscillators which I am going to use consist of a capacity and a self-induction which are so chosen as to give a very rapid period of oscillation, so that effects are produced by an alternating current with these oscillators which could not be produced by the alternating currents alone. I will now show you by means of a simple model what the character of these is. I have a spring which you see here (Fig. 33). It has a natural period of oscillation. I have applied a strip of paper to the piece of watch-spring, so that I can blow against it and produce a disturbance. The velocity of the motion represents the amperes of the current; and what I want to show you is that I can get far more powerful currents from this by a broken current than I can by using an undulatory current. I have arranged it so that in the first place I move a jet of air up and down so as to be undulatory in it character. [*Experiment.*] There, now notice the amount of the motion and the amount of the velocity. You notice it moves backwards and forwards as the air pressure increases, and the velocity is comparatively slow.

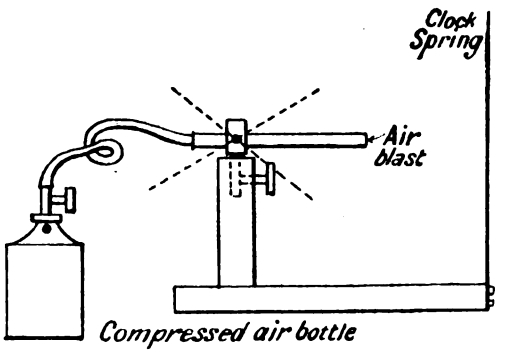

Fig. 33.

Now, I am going to use the same jet of air, but instead of passing it so as to be continuously pressing upon it, but with more or less force, I am going to pass it across the spring so as to be acting upon the spring only for a minute space of time, and then leave it to its own oscillation. [*Experiment.*] There, you see the velocity is 100 times as great as it was before, although the amount of pressure which I am applying summed up over a second is not nearly so great, and yet I get enormously more velocity than I did before when I was applying an undulatory current. In the electrical analogy, if I have an oscillating system I am able to produce a far greater current by allowing it freely to oscillate than if I apply a gradually increasing and diminishing current to the system.

Now, as an illustration of this I will show you an experiment with the oscillatory discharge. These oscillatory discharges of high voltages have been used so frequently of late years that I suppose most people have seen them. At the same time they are very instructive experiments, and it will not take but a few moments to arrange them. I just wish to show you the lighting up of a tube (Fig. 34). The experiment was first shown in

Fig. 34.

this room extremely well by Mr. Nikola Tesla, of America, some few years ago, and it has justly gone by his name ever since. The oscillations are transmitted through my body and are able to light up the tube. [*Experiment.*] Here you see the tube lights up through my body, and the oscillations are shown by the intervals of light. It lights up only when the discharge has taken place, and you are thus enabled to see the nature of the oscillatory discharge.

I have now come to the end of the experiments which illustrate this part of my subjects, and I feel sure that those of you who have listened to these lectures, and have seen the admirable arrangements which Mr. Campbell Swinton has made, will not be disappointed if I show you another experiment, using the same apparatus but not connected with the subject of the lecture. The experiment is a very remarkable one, and is originally due to Lord Armstrong. He first found it out when using a hydro-electric machine in which he got great currents at high pressures by means of a jet of steam. In the arrangements which I am showing you I get the high E.M.F., or rather Mr. Campbell Swinton has obtained it, by using an induction coil, and using a continuous current through the induction coil. In most of the experiments which I have been working before, we have used an alternating current, because if we had used a con-

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tinuous one we could not have interrupted it rapidly enough. In the present instance we are using a continuous current. From experiments I have shown you before, you know that when we make contact with a primary there is an induced current in the secondary, and a reverse one at break. We are able to almost eliminate the current in one direction, and to thus secure the secondary current almost entirely in one direction; and this is emphasised by having a spark gap which the current has to leap over, and which is wide enough to prevent the spark passing at the make, but not too wide to prevent it passing at the break. This is really an experiment on continuous currents, and not on either alternating or interrupted currents.

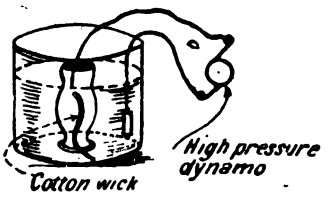

Fig. 35.

In this experiment the apparatus (Fig. 35) is not shown on the screen inverted: it is shown in the same position as it is on the table in front of the lamp. Here, in a square glass trough, I have an inverted bulb, open at the top and open at the bottom, with a piece of cotton wick coming through the narrow neck-like opening at the bottom of the bulb. The wick is at present coiled up in the bulb, and a short end is projecting into the liquid below. The high-pressure electric current is taken to the water outside, and the other terminal to the water inside the bulb. According as I pass the current in the one direction or the other so the cotton wick will be seen to move out of the bulb, or to be retracted again into the bulb; and the most remarkable feature about this is that at the same time that the cotton wick is moving in one direction the water is moving in the other, and by the projection on the screen you will actually be able to see the direction in which the water is moving. In order to carry out this experiment, the purest distilled water is necessary, and provided everything goes well we ought to see the motions easily.

I may say that Lord Armstrong has shown this experiment to a few of his friends, and Mr. Campbell Swinton has shown it to me and others, but very few persons have seen it. I can only say, in explanation, that it is probably due to the same phenomena as electrical endosmose. If you have a vessel of liquid with a septum of porous material, there is an electrical action between the septum and the liquid which tends to draw the liquid through the septum, and it is probably a mutual action between the porous material and the water. Probably this is the same effect exhibited in this experiment; there is a mutual action between this wick end and the water outside, and the mutual action causes the one to be drawn downwards and the other to be pushed upwards. [*Experiment.*] Now you will notice that the water is rising in the bulb, and the wick is coming out at the bottom. We will reverse the current, and as soon as we do that you will see that the action takes place in the opposite direction, and the wick is going upwards while the water is going out at the bottom.

MOUNTAIN-CLIMBING RAILWAYS.

BY ERNEST SCOTT.

(Concluded from page 456.)

The Lauterbrunnen Railway is worked by water ballast, and has a gradient of 60 per cent., the minimum being 42 per cent. It connects the rack railway to Interlaken with the electric railway from Grutsch to Murren. As the gradients vary all the way up, provision is made for equalising the differences in stress on the wire rope by allowing the water in tank of the descending car to gradually run out. A concrete channel in the permanent way carries away the waste water. To guard against the front wheels mounting the rails during the ascent, a pair of grappling irons are fixed to the car, and travel loosely along the underside of the rack flanges. In the event of the car lifting above ⅛in. they clutch the flanges. Two cocks are provided for playing water on to the brake wheels in the descent.

The electric railway from Grutsch to Murren is worked by electric locomotives and overhead trolley wire. Current is generated at 600 volts by a Brown dynamo, direct coupled to an Escher, Wyss, and Co.'s turbine. A noteworthy feature of the motors is that they do not require more than *double* the normal current at starting. This is low, and is due to the spring suspension of the motor, the elastic medium thus provided assisting in overcoming the inertia of the tram. The mean fare for the up and down journey is about 7¾d. per mile, and the total number of passengers carried per day is 600.

Table I. gives particulars of the most important mountain railways that have been laid down. Where separate locomotives are used, they are invariably arranged so as to push the passenger car up the mountain side. The ordinary tee or Vignoles type of rail is almost invariably employed, because the broad flange is easily secured to the sleepers. The steepest gradient is that of the Stanserhorn, 61 per cent., and this is the only line on which the rack has been dispensed with altogether. The cost of construction and equipment per mile of track varies very considerably, from £50,000 to £14,000. In the most recent cable railways, with the winding drums worked by electric motors, it is about £25,500. The percentage of working expenses to receipts varies, with a few exceptions, between 85 and 45 per cent., the average working cost per car mile being 5d. The total weight of permanent way, including rails, rack, sleepers, and fastenings, averages about 200lb. per yard. Creeping of the rails is one of the principal difficulties in laying the permanent way of these lines. It is usual to fix iron anchors, or creep arresters (firmly embedded in the concrete or masonry), to every fourth or fifth sleeper. Owing to the question of stability under wind pressure, the cars are always built of the half-open type with cloth hangings, which in ordinary weather may be drawn, but in case of a high wind must be close reefed. The radius of the curves employed is often very small, and as the wheel base of the cars and locomotives are always fixed it is usual to increase the width of gauge slightly, the outer rail being also raised to allow for centrifugal force. For a radius of 600ft. the gauge would be increased 1-16in., and the outer rail raised ¼in., whilst for a radius of 300ft. the gauge would be increased 3·32in., and the outer rail raised 1⅛in. This is for a 3ft. 3⅜in. gauge; it would, of course, have to be slightly modified for a different gauge and according to the wheel base. One of the sharpest curves employed is that on the Wengern Alp Railway, 197ft., with a gauge of 2ft. 7½in. Steam locomotives usually carry four sets of braking gear, all of which can be operated from the foot-plate—viz., air brake, two rack-wheel brakes, and a steam brake; this latter in the electric locomotive having its counterpart in the electric brake or the motor working as a dynamo. On the Swiss and German railways the important work of putting down the foundations, laying the permanent way, and tunnelling is nearly always done by Italian workmen, who have gained for themselves quite a reputation for good work. They are paid about 25s. per week. The cost of masonry runs out at about 8s. per cubic yard, and tunnelling £16 per lineal yard.

The lines already projected in this country are Snowdon (3,571ft.), Ben Nevis (4,373ft.), Arthur's Seat, and Snaefell (2,000ft.). The site for the line of the first named has already been surveyed and work has commenced. The Abt differentiated rack is being used, and the gauge of the rails is 2ft. 7½in. It is proposed to use a waterfall as the source of power, driving dynamos by means of turbines, the current being supplied to the motor cars at 500 volts by overhead trolley wire. The motor car will carry 66 passengers, and the trailer, which will be used in busy seasons, another 40. The length of the line is about 4½ miles long, and the maximum gradient 17 per cent., with curves of 350ft. radius. The pitch of teeth in rack is 4·72in., and the rack wheels are 18in. diameter with 12 teeth. Two steam locomotives have been ordered and will be used for the construction of the line and for making tests. The Snaefell line will be finished this year.

A good deal of public interest has been awakened in connection with this railway up Snowdon. The Society for the Preservation of Sites of Historical Interest and Natural Beauty have, through Mr. H. D. Rawnsley, of Bangor, published an energetic protest against the railway being built—the following being one of the most telling paragraphs: "What we protest against most, however, is the commercialising of scenery. Snowdon unrailwayed, unvulgarised, and unexploited is a better investment for Wales, for Llanberis or any of the villages that cluster round its base, than Snowdon turned into a mixture of tea-garden and switchback. The love of natural scenery, hardly more than a century old in Great Britain, is working gradually downward into the mass of the people, and the inevitable crowding of the cities, with all the accompaniment of train and tram, as inevitably makes men desire more and more something that is without these accompaniments for their rest and enjoyment." Notwithstanding this strong local appeal, Mr. Assheton Smith, the proprietor of part of Snowdon, who has on several previous occasions opposed railways up Snowdon on æsthetic grounds, has changed his views and now given facilities to the promoters of the new scheme.

It is hardly necessary to point out the almost noiseless working by electricity, and that mechanical structures are not always, if ever, an eyesore—*e g.*, the Forth Bridge, about the design of which so much was said from the æsthetic point of view. In this connection it may be interesting to recall one or two of the objections urged in the Houses of Parliament against the introduction of the steam railway: "The country gentry were told that the smoke would kill the birds as they passed over the locomotive. Even cows, it was said, would cease to yield their milk in the neighbourhood of one of these infernal machines. Sir Isaac Coffin asked what was to become of coachbuilders and harness makers, coachmasters and coachmen, innkeepers, horse breeders, and horse dealers, and went on to say that iron would be raised in price 100 per cent. or probably altogether exhausted. It would be the greatest nuisance, the most complete disturbance of quiet and comfort in all parts of the kingdom that the ingenuity of man could invent."

The question has often been asked, What is the good of rack railways? In reply to this question, we can give the omnipresent if sordid argument that it causes trade and circulates some money. It enables invalids to breathe the invigorating air of the high mountains. It has rendered accessible, with comfort and ease, mountain heights the view from whose summits had before been possible

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SUMMIT LEVELS, ETC., OF MOUNTAIN RAILWAYS.

Name.	Location.	Height in feet above sea-level.	How worked.	Type of rack.	Power.
Superga	Turin	2,106	Rack and wire rope	Agudio	Wire rope locomotor
Giessbach	Brienz	2,175	Rack and wire rope	Abt	Stationary steam engine
Buchberg Pass	Baden	2,302	Adhesion	—	Steam locomotive
Rowhach-Heiden	Constance	2,598	Rack	Abt	Stationary steam-engine
Utliberg	Zurich	2,677	Rack and wire rope	Abt	Stationary steam-engine
Offenburg and Singen	Black Forest	2,730	Adhesion	—	Steam locomotive
Northern Pacific	United States	2,854	Adhesion	—	Steam locomotives
Rama-Sarajevo	Bosnia	2,874	Rack and adhesion	Abt	Steam locomotive
Burgenstock	Lucerne	2,884	Rack and wire rope	Abt	Electric motor station
San Salvatore	Lugano	2 897	Rack and wire rope	Abt	Electric motor station
Wädenswell-Einziedeln	Zurich	2,900	Adhesion	—	Steam locomotives
Höllenthal	Black Forest	2 903	Adhesion and rack	Ladder	Steam locomotives
Semmering	Austria	2,946	Adhesion	—	Steam locomotives
Swiss, South-Eastern	Altmatt Pass	3,040	Adhesion	—	Steam locomotive
Usui and Toge	Japan	3,090	Adhesion and rack	Abt	Steam locomotive
Brunig Pass	Lucerne	3,293	Adhesion and rack	Locher	Steam locomotives
Tonque	Jura	3,326	Adhesion	—	Steam locomotives
Grindelwald	Interlaken	3,467	Adhesion	—	Steam locomotives
Beatenberg	Lake Thune	3,660	Rack and wire rope	Abt	Water ballast
Mont Salève	Geneva	3,746	Rack	Abt	Electric motor cars
St. Gothard	Italy	3 788	Adhesion	—	Steam locomotives
Kaju Tanam	Sumatra	3,808	Rack and adhesion	Ladder	Steam locomotive
Mount Vesuvius	Italy	3,891	Wire rope	—	Stationary steam-engines
Mont Serrat	Spain	4.057	Rack	Abt	Steam locomotive
Mont Cenis	France	4 250	Adhesion	—	Steam locomotive
Arlberg	Switzerland	4.297	Adhesion	—	Steam locomotive
Canadian Pacific	Canada	4,304	Adhesion	—	Steam locomotive
Brenner	Switzerland	4,484	Adhesion	—	Steam locomotive
Lauterbrunnen-Grutsch	Bernese Oberland	4 887	Rack and wire rope	Riggenbach ladder	Water ballast
Aix-les-Bains	Revard	4,956	Rack	Abt	Steam locomotive
Beirut and Damascus	Asia Minor	5 000	Rack and adhesion	Abt	Steam locomotive
Visp Zermatt	Switzerland	5 278	Adhesion and rack	Abt	Steam locomotive
Grutsch-Murren	Bernese Oberland	5,350	Adhesion and rack	Abt	Electric locomotive
Davos Platte	Switzerland	5,357	Adhesion	—	Steam locomotive
Mont Generoso	Lugano	5 376	Rack	Abt	Steam locomotive
Rhigi	Lucerne	5,741	Rack	Riggenbach ladder	Steam locomotive
Llanslebourg	Mont Cenis	5,880	Double rack	Agudio	Wire rope locomotor
Wengern Alp	Interlaken	6,183	Rack	Riggenbach ladder	Steam locomotive
Stanserhorn	Lucerne	6,200	Wire rope	—	Electric power station
Mount Washington	United States	6,262	Rack	Ladder	Steam locomotive
Glion-Naye	Geneva	6,397	Rack	Abt	Steam locomotive
Pilatus	Lucerne	6,778	Rack	Locher	Steam-engine car
Scheynig Platte	Interlaken	6 791	Rack	Abt	Steam locomotive
Mount Wilson, Pasadena	Southern California	7,000	Wire rope	Abt	Electric motor station
Central Pacific	United States	7,021	Adhesion	—	Steam locomotive
Rothhorn	Brienz	7,388	Rack	Abt	Steam locomotive
Mainton and Pikes Peak	United States	7,500	Rack	Abt	Steam locomotive

only to the young, sound in body and of athletic tendencies. Those who have seen the little miniature trains slowly toiling up the mountain side cannot but think that, after all that has been said to the contrary, modern progress is no foe to the finer things of life, but an ally bringing to millions privileges and pleasures which hitherto have been denied to all but few. Excursionists whose time is very limited have also to be considered, and although the fare when calculated out per train mile and compared with the ordinary rate of 1d. per mile appears high, there is no doubt, the large and increasing number of people who travel and get their knowledge of the country by excursions will welcome the innovation. These railways give ready access to observatories already built, and by cheapening the cost of transportation will probably be the means of multiplying the number of observatories.

Although none of the hills of these islands look like mountains when compared with the huge and high masses of the Continent, yet there is considerable scope for mountain-railway speculation. For instance, Helvellyn, 3,166ft.; Ingleborough, 2 400ft.; the Peak, 1,800ft.; Snaefell, in the Isle of Man, 2,000ft.; Plinlimmon, 2 500ft., containing the sources of the Severn and the Wye; Ben Macdin, 4,300ft.; Ben Lomond, 3,200ft. These and many others are visited by an increasing number of tourists every summer, and in nearly every case there is sufficient water power available within a radius of four or five miles. It is, however, in rack and adhesion lines with gradients up to 10 per cent, such as are met with on country roads all over the British Isles, that we shall have the greatest and most beneficial development. The cost per mile, including electrical equipment of road railways, 3ft. 3⅜in. gauge, suitable for country districts, is about £6,000 per mile. As an instance may be mentioned the short railway from the Lake of Lucerne to the foot of the Stanserhorn, which cost only £4,500 per mile. It is three miles long, metre gauge, and runs along the highway, leaving 13½ft. for ordinary vehicular traffic. Although there are only 12 trains per day each way, and a resident population of only 3,000, it has already yielded a return of 4 per cent. on the capital. This is an ordinary adhesion line and an exceptionally low cost per mile.

Combined rack and adhesion lines come out considerably higher, from £10,000 to £30,000 per mile, the cost varying according to the gradients, cost of transportation of material, character of rock formation on hilly section, etc. Table II. gives particulars of some of the principal rack and adhesion lines. The question whether simple adhesion or rack and adhesion is preferable depends on local conditions, requirements of traffic, etc.; for instance, the electric tramcars on the Florence, Genoa, and Zurich travel at eight miles an hour up grades of 8, 7, and 6 per cent., depending on adhesion only. It must be remembered, however, that they are only tramcars of the ordinary seating capacity (about 40), and there is no special provision for luggage.

The light railways for serving agricultural and country districts which are being talked about at the present time will probably have a train load of 60 to 90 tons, and besides giving seating capacity for 200 will have several luggage vans. For such railways the combined rack and adhesion system will be found to be the most suitable—the adhesion gradients being worked up to, say, 3 per cent. and rack grades from that up to 10 per cent. or more, if necessary.

Now that the much-talked-of Jungfrau Railway is again to the front, it may be interesting to recall Colonel Locher's ingenious suggestion for carrying passengers above the perpetual snow-line. His device is that two circular tunnels be cut as nearly straight as possible, through which the cars, acting as pistons, are pushed up by compressed air, the air being supplied by centrifugal fans at about 1½lb. per square inch. He estimates that the ascent of the Jungfrau could be accomplished by this method in about 15 minutes at a speed of 15 miles per hour.

A short bibliography is appended, which will be useful to those who wish to follow the subject further. Mr. du Riche Preller is the best English authority, and his writings on this subject are very extensive. Authentic data with regard to costs of construction and maintenance, etc., can be got from the statistics which the Swiss Federal Government publish from time to time.

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TABLE I.—PARTICULARS OF SEVERAL MOUNTAIN RAILWAYS.

Name and location.	Year of opening	Length, miles.	Maximum rise in feet.	Highest point above sea-level in feet.	Gauge.	Weights.	Rails.	Rack.	Gradients.	Speed in miles per hour.	Number of passengers.	Cost of line.	Cost of line and equipment per mile.	How worked.	Remarks.
Righi-Vitznau, Lucerne, Switzerland.	1871	4·35	4,200	5,741	4ft. 8½in.	Engine, 12½ tons; train load, 28 tons.	35lb. per yard.	Riggenbach's ladder.	Average, 22 per cent.; maximum, 25 per cent.	3	82	£89,400	£20,416	Steam locomotive.	Vertical boiler; locomotive separate from passenger car.
Mount Pilatus, Lucerne, Switzerland.	1889	2·77	5,382	6,778	2ft. 7½in.	Total train load, 18 tons.	40lb. per yard.	Locher's double rack back-to-back.	Average, 36·6 per cent.; maximum, 48 per cent.	2·2	35	92,460	35,904	Steam locomotive car.	Car wheels without flanges; locomotive and car in one; boiler horizontal, placed transversely to track.
Maniton and Pikes Peak, United States.	1891	8·75	7,525	14,300	4ft. 8½in.	Engine, 32 tons.	40lb. per yard.	Abt double rack.	Minimum, 12½ per cent.; maximum, 25 per cent.	6	100	—	—	Steam locomotive.	Engines by Baldwins, of Philadelphia; cylinders 18in. diameter, 24in. stroke; six driving cogwheels, two being for emergencies.
Catskill Mountains, United States.	1892	1·3	1,630	—	3ft. 0in.	Car complete, 14 tons.	35lb. per yard.	Abt rack, 23lb. per yard, as a safety factor only.	Minimum, 4 per cent.; maximum, 34·4 per per cent.	8	75	—	—	Cable railway, with steam power.	Engine and boiler house at summit; winding drums 12ft. diameter; Abt rack used for safety purposes only. Erected by Otis Elevating Company.
Brienz-Rothhorn, Switzerland.	1892	4·75	5,180	7,388	2ft. 7½in.	Engine, 17 tons; total weight, 26 tons.	40lb. per yard.	Abt double rack, 35lb. per foot.	Maximum, 25 per cent.	4	48	84,000	17,684	Steam locomotive.	Road wheels 1ft. 9in. diameter, run loose on axle; rack wheels 18in. diameter, with 12 teeth; engine cylinders 12in. diameter, 22in. stroke; wheel base 4ft.
Mount Salève, Savoy.	1893	5·59	2,700	3,746	3ft. 3⅜in.	Car body, 4·4 tons; motors and gearing 6 tons; total weight, 14 tons.	30lb. per yard.	Abt single and double rack.	Minimum, 8 per cent.; maximum, 25 per cent.	5	44	92,000	15,660	Electric motor car.	Each car supplied with two 40-h.p. double-reduction motors, running at 600 revolutions, and speed reduced 13 to 1; current supplied by third rail, main lines and rack being used as return.
Burgenstock, Lucerne, Switzerland.	1888	·59	1,443	2,884	3ft. 3⅜in.	Car empty, 4 tons; total weight, 6 tons.	45lb. per yard.	Abt double rack with anchor as a safety factor.	Minimum, 32 per cent.; maximum, 58 per cent.	2·3	40	15,920	25,728	Cable railway, with electric transmission of power — 1,600 volts.	Cable railway; two series-coupled Thury motors, each 60 h.p., at the summit drive the winding drum through gearing having a total reduction of 140 to 1.
Monte Salvatore, Lugano.	1890	1·1	1,972	2,897	3ft. 3⅜in.	Car empty, 4·5 tons; total weight 6·8 tons.	35lb. per yard.	Abt double rack with anchor as a safety factor only.	Minimum, 17 per cent.; maximum, 60 per cent.	2·3	40 standing room for 10 more.	27,610	25,100	Cable railway, with electric transmission of power — 2,000 volts.	Motor station midway up the incline, which is worked in two sections. Oerlikon (Brown) 75-h.p. motor works the winding drums through gearing.
Stanserhorn, Lucerne.	1893	2·5	4,590	6,080	3ft. 3⅜in.	Car empty, 4·5 tons; total weight 6·8 tons.	40·25lb. per yard	No rack.	Minimum, 12 per cent.; maximum, 61 per cent.	2·3	40 standing room for 10 more.	66,750	26,700	Cable railway, with electric transmission of power — 1,600 volts.	Three sections and three motor stations, each having a 40-h.p. Thury motor; current generated at 1,600 volts pressure at the same power station as for Burgenstock.
Wengern Alp, Interlaken.	1893	10·68	—	6,183	2ft. 7½in.	Car empty, 5·07 tons; total weight 8 tons.	41½lb. per yard	Riggenbach's ladder.	Maximum, 20 per cent.	5	48	160,000	14,247	Steam locomotive.	Locomotives of the Abt type; they have two rack wheels, each of 18 teeth.

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Lanslebourg, Mont Cenis (French slope)	1868	·83	1,150	5,880	4ft. 8½in.	Locomotive, 12 tons; train, 24 tons.	—	Agudio double rack, back to back.	Average 26 per cent.; maximum, 31·8 per cent.	5	—	—	40,000	Wire-rope locomotor.	Rope travels, at 23 miles per hour, by side of rack. Rack made out of flat steel bar, crimped to form teeth while hot. Section of bar, 4⅜in. by ½in.
Lauterbrunnen to Grutsch, Bernese Oberland.	1890	·75	2,214	4,887	3ft. 3⅜in	Car, 7·8 tons; passengers and luggage, 3 tons.	40·3lb.	Riggenbach ladder as safety factor only.	Minimum, 42 per cent.; maximum, 60 per cent.	3	30 standing room for 10 more.			Ballast water system, with wire cable.	Stress in cable is equalised by allowing water in descending car to gradually run out into concrete channel in permanent way.
Grutsch to Murren, Bernese Oberland.	1891	2·7	492	5,350	3ft. 3⅜in.	Locomotive, 7·2 tons; passengers and luggage, 3·5 tons.	35lb.	Riggenbach ladder as safety factor only.	Minimum, 3 per cent.; maximum, 5 per cent.	7	40	18,624	60,000	Electric locomotive, overhead trolley.	Two 30-h.p. motors to each car; current generated at 600 volts by dynamo driven by turbine.
Barmen, Rhenish Prussia.	1894	2·0	550	—	3ft. 3⅜in.	—	35 lb. grooved tram rails in streets.	Riggenbach ladder.	Minimum, 14 per cent.; maximum, 18·5 per cent.	4½	28 standing room for 8 more.	—	—	Electric motor car; two oblong metal frames collect from overhead wire.	Eight motor cars; each car has two axles carrying toothed wheels, and revolved by two 36-h.p. Siemens-Halske motors, 500 volts.

TABLE II.—MOUNTAIN RAILWAYS WORKED ON COMBINED RACK AND ADHESION SYSTEM.

Name.	Location.	Year of opening.	Mode of operating.	Length of rack. Miles.	Length ordinary adhesion. Miles.	Total length of line. Miles.	Maximum gradient. Per cent.		Sharpest curves.		Number of locomotives.	Weight of locomotive. Tons.	Tractive power. Tons.	Train weight. Tons.	Gauge of rails.	Rack.	Highest point above sea-level, in feet.
							Rack.	Adhesion.	Rack.	Adhesion.							
Harz	Brunswick, Germany	1884	Pushing	4·66	14 29	18·95	6·0	2·5	8° 45′	9° 15′	5	61	13	148	4ft. 8½in.	Ladder	—
Lebestin	Thuringia, Germany	1885	Pushing	0·81	0·87	1·68	8·0	3·5	11° 30′	11° 30′	1	25	6½	55	4ft. 8½in.	—	—
Oertelsbruch	Thuringia, Germany	1885	Pushing	0·43	2 68	3·11	13·5	5·0	17° 30′	51°	2	6½	2¼	8	2ft. 3½in.	Ladder	—
Visp Zermatt	Switzerland	1889	Pulling	4 66	7·51	2·17	12·5	2·8	17° 30′	22°	5	32	10	50	3ft. 3⅜in.	Abt	5,278
Rama	Sarajevo, Bosnia	1890	Pulling	11·12	31·13	42·25	6·0	1·5	14°	14°	8	33	9	92	2·43ft.	Double Abt	2,874
Eisenerz	Vordernberg, Austria	1890	Pushing	9·01	4·04	13·05	7·1	2·5	9° 45′	11° 30′	12	61	13	132	4ft. 8½in.	Abt	—
Tiransandino	Chile, S.A.	1890	Pushing	17·40	13·67	31·07	8·0	2·5	8° 45′	15° 15′	6	46	9	66	3ft. 3⅜in.	Abt	—
Frieburg and Neustadt	Höll Valley, Baden	1887	Pushing	4·40	18·20	22·60	5·6	2·5	8 chains	—	—	36	9	100	4ft. 8½in.	Ladder	2,903
Brunig Pass	Switzerland	1891	Pushing	5·70	30·70	36·40	12·0	2·5	7 chains	—	—	23	8	84	3ft. 3⅜in.	Ladder	3,293
Kaju Tanam	Sumatra	1893	Pushing	18·00	81·80	99·80	8·0	2·2	7 chains radius	7 chains radius	—	24	7	80	3ft. 3⅜in.	Ladder	3,808
Diakopto	Kalavryta, Greece	1891	Pulling	2·24	12·05	14·29	14·5	3·5	35° 30′	61°	3	17½	5½	17½	2ft. 5½in.	Abt	—
S. Domingo	West Indies	1891	Pulling	3·98	18·39	22·37	9·0	4·0	17° 30′	35° 30′	4	27½	8	55	2ft. 6in.	Abt	—
Usui and Toge	Japan	1893	Pushing	5·28	7·15	12·43	6·7	2·5	6° 40′	—	4	39	11	110	3ft. 6in.	Treble Abt	3,090
Beirut and Damascus	Asia Minor	1894	Pulling	20·00	20·00	40·00	6·0	—	6 chains radius	5 chains radius	—	43	11	143	3ft. 6in.	Abt	5,000

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THE SELECT COMMITTEE ON TELEPHONY.

The Select Committee of the House of Commons on the Telephone Service on Friday had under cross-examination **Mr. J. S. Forbes**, chairman of the National Telephone Company. In order to test the allegation that the service was inefficient by reason of delays, he put in a statement of local messages, exclusive of trunk messages, for one day (April 3, 1895) passing through the exchanges at Glasgow, Aberdeen, and Edinburgh. It showed that in Glasgow, out of 69,406 messages dealt with, 59,020 occupied less than half a minute in placing subscribers in effective communication; in 2,694 cases five minutes and over were occupied, the reasons for delay given being that the subscribers did not answer quickly or the junction lines being engaged. Broadly speaking, similar results were brought out in Aberdeen and Edinburgh. At the London Queen Victoria-street exchange, the number of messages dealt with by one operator in charge of 50 subscribers during seven hours on the same day was 508, of which 176 occupied under half a minute, 146 under one minute, 116 two minutes. He put in a return of local messages through the more important exchanges on the company's system, from which it appeared that in the Lime-street exchange, London, there were 2,135 subscribers, the number of local messages per day, including Sundays, and exclusive of trunk messages, being 22,625, and the cost to subscribers per message was 1·04d. In Liverpool there were 3,938 subscribers, the number of local messages per day was 96,644, and the cost to subscribers per message ·25d. In Manchester there were 2,962 subscribers, and 70,952 local messages per day, and the cost to subscribers per message ·27d. The telephone was therefore very much less used in London than in Liverpool or Manchester. In London it did not appear to be so much an essential of the commercial machine.

Mr. Benn: Is that not because in London the charge is higher? No; the greater the business, the more the instrument is worked to its full capacity, the less the charge.

The **Chairman**: And probably the more effective the telegraph service, the less demand for the telephone service?—It is a problem for this committee why it is that London compares so unfavourably with the great provincial towns.

Mr. Benn: May it not be because in London the system is inefficient?—I have not contended that ours is the perfection of service. No doubt people are irritated by what appears sometimes to be unusual delay. They wait for a second or two, and they think it must be a minute. In Germany, with all their perfection, people have to take their turn. They are disciplined to wait; we are not. He continued that, notwithstanding defects, the service was growing, and as evidence of its growth he mentioned that in the United Kingdom the number of new subscribers to the company's system during the year ending December, 1894, was 12,502, the number who had ceased to be subscribers being 4,410; while in London the numbers of new and ceased subscribers were respectively 1,596 and 806. He discussed the question whether it was better to have one uniform moderate tariff over an extensive area or a series of concentric circles, with varying rates for each half-mile or other fraction of a mile, and gave his opinion that the latter course was possible, but extremely inconvenient, and he put in a return to show that it was not popular in London. This return showed the number of subscribers on the metropolitan exchanges having a limited local service and the number on the same exchanges having full metropolitan service. The local service includes free speaking between Sydenham, Bromley, Redhill, Epsom, and Streatham. The number of subscribers to the local service was—in Croydon, 61; Kensington, 3; Kingston, including Richmond and Wimbledon, 2; Battersea, 1; and eastern, 3. The numbers of subscribers having full metropolitan service, on the other hand, were, in the same exchanges, 250, 342, 36, 67, and 279 respectively. The number of private houses connected in the Metropolis was 492. Uniformity, combined with moderation, was the policy which the company pursued. The witness also put in a return of the number of lines and population in various centres as at December last, which, he said, showed that at these particular centres the rates of the National Telephone Company bore favourable comparison with similar places in America, and that they had not made such a poor advance in the development of the telephone in this country as was sometimes asserted.

On Tuesday, Mr. Arnold Morley presiding, Mr. J. S. Forbes, chairman of the National Telephone Company, was further cross-examined.

Replying to **Sir C. Cameron**, the **Witness** gave information as to the terms on which different companies had been bought up by the National Company. The construction capital of these companies was £1,813,000, and the purchase value £3,105,000. The amount of what some people called watered value—though, he remarked, there was a good deal of "spirit" in it—was £1,292,000.

In reply to **Sir J. Fergusson**, he estimated that in London the metallic-circuit system would be completed by the end of the year. Manchester was undergoing the same transformation, and Glasgow was being arranged for. Within the year he thought that, if they received the necessary facilities, they would be able to complete the lines so as to fulfil the engagements they had entered upon.

Questioned by **Mr. Tully**, he said that if cheap rates were to be brought about by municipalities it meant that merchants, manufacturers, financiers, and other people who used the telephone could well afford to pay a great deal more than they did pay, for the users were to be relieved at the expense of the general good.

In answer to **Mr. Snape**, he further stated that every man in England could use the telephone for 6d. a day, and, therefore, he did not think it was beyond the resources of the class of shopkeepers and small tradesmen if they required it.

Mr. A. C. Morton, M.P., put in a statement on behalf of the City Commissioners of Sewers, to show that there was considerable dissatisfaction on the part of telephone users in the City with regard to the service of the National Telephone Company.—*The Times.*

LEGAL INTELLIGENCE.

MUIRHEAD v. THE NATIONAL ELECTRIC SUPPLY COMPANY, LIMITED.

This was an action by Mr. John Muirhead, a former director of the National Electric Supply Company, Limited, to recover £300,

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being the sum due for director's fees incurred between 1891 and 1894. By the articles of association it was provided that the remuneration of the board of directors should be £200 per annum to the chairman and £100 per annum to each of the other directors. The memorandum of association provided that there should first be set aside out of the net profits of the company such percentage thereof as should from time to time be appropriated by the articles of association to payment of directors' remuneration. Mr. Muirhead was an ordinary director. No net profits had, in fact, been made by the defendant company.

Mr. McCall, Q.C., and **Mr. Clauson**, for the plaintiff, argued that the fees were payable although no profits had been made. "*Re* Lundy Granite Company, Harvey Lewis's Case" (26 L.T., 673; "Isaac's Case" (1892, 2 Ch., 158).

Mr. J. Eldon Bankes, for the defendants, argued that upon the construction of the memorandum and articles in question when read together the agreement between the company and the directors was that the fees should be payable only out of profits

Mr. Justice Day, on Friday last, gave judgment for the defendant company, holding that Harvey Lewis's case (*ubi sup.*) was decided upon grounds not applicable to the present case, and that upon the construction of the memorandum and articles of the defendant company the directors' fees were not payable except out of profits, and that, there being admittedly no profits, the plaintiff's claim failed. His lordship granted a stay of execution for seven days, and directed that the £300, which had been paid into Court under the Master's order, should remain there pending an appeal.

FOWLER v. THE CHELSEA ELECTRIC SUPPLY COMPANY—SANDON v. THE CHELSEA ELECTRIC SUPPLY COMPANY.

The first of these actions (heard before Mr. Justice North on Friday last) was by the tenant of a flat at the mansion, 75, Cadogan-gardens. The second was brought by the landlord and tenants of other flats in the house. In both actions it was sought to restrain the defendant company from continuing an alleged nuisance occasioned by noise and vibration. The actions were brought on on motions for interlocutory injunctions. It was arranged in each case that the motion should stand till trial, the writs being treated as statements of claim, the defendants to put in statements of defence within a fortnight, and leave being given to apply to have the trials expedited.

Mr. Swinfen Eady, Q.C., with Mr. Rowden, and Mr. Samuel Hall, Q.C., with Mr. Badcock, were for the respective plaintiffs; Mr. C. A. Cripps, Q.C., Mr. Vernon Smith, Q C, and Lord Robert Cecil for the defendants.

COMPANIES' MEETINGS.

HASTINGS AND ST. LEONARDS ELECTRIC LIGHT COMPANY, LIMITED.

The annual general meeting of this Company was held at Hastings on Thursday last week, Mr. F. A. Langham occupying the chair.

The report, which was taken as read, was as follows: "The directors present to the shareholders the annexed accounts for the past year, duly audited by the Board of Trade, in accordance with the provisional order. The past year has been an eventful one in the history of the Company, and although, for reasons easily to be explained, the directors are unable to declare a dividend, they consider the Company to be in a sound financial position, the amount earned having been £6,641, as against £5,390 in 1894. It will be seen that large outlay has been incurred in the purchase of additional premises, as well as for new machinery, and arrangements have been completed with the ground landlord whereby the old leases of the four blocks of buildings which now constitute the extensive works of the Company have been surrendered, and a new lease of the whole granted, so that the Company now possess amply sufficient space for a large and increasing business for many years to come. Owing to the change of electric supply from the high-tension direct-current system to the alternating high-tension transformer system, considerable outlay had to be incurred in alterations of consumers' fittings, etc., and this outlay had to be charged to the revenue account. This, however, was exceptional, and will not again occur. A large sum had also to be expended on the public lighting, from which income has only been received since 1st July last. The directors, finding that the installation work was not remunerative, have abandoned it, and sold the stock in-trade, and for the future intend to devote their efforts to the supply of the light only, and they trust that arrangements (now under consideration) will be shortly made whereby a large reduction in the cost of the light can be made to large consumers, not only without detriment to, but to the improvement of, the income of the Company. Messrs. H. M. Baker and G. Roddis retire from the directorate by rotation, but they are eligible, and offer themselves for re-election. The auditors, Messrs. Hart Bros., Tibbetts, and Co., also retire, and offer themselves for re-election."

The **Chairman** moved the adoption of the report, and **Mr. Tyrrell** seconded the motion, which, after some discussion, was adopted.

Mr. Roddis was re-elected a director, and Mr. A. L. Ward was appointed a director in the place of Mr. Baker, who did not offer himself for re-election.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The twenty-ninth ordinary general meeting of this Company was held last week at the Cannon-street Hotel, Mr. W. S. Andrews occupying the chair.

The **Chairman**, in moving the adoption of the report and accounts, said the receipts for the half-year had amounted to £82,815, against £80,338. There was a small increase in the international words exchanged—namely, about 14 per cent.—but a decrease of 18 per cent. in the words exchanged internally; still, notwithstanding that decrease in the words exchanged in Brazil itself, there was a small augmentation in the amount of money derived from that traffic, arising from the circumstances that the messages were conveyed, on an average, a greater distance than in the corresponding period of 1893. The expenses last half-year were £36,403, against £35,592. After deducting £11,601 for debenture interest, and £5,000 for the debenture redemption, there remained £40,059, of which £8,000 had been placed to the reserve fund. The Board now recommended the payment of a dividend of 6s. per share for the half year, making, with the interim dividend 3 per cent. for the year. The item of exchange was the governing factor in their business, and with a satisfactory exchange the Company would be able to give a very gratifying account of its operations. With reference to the litigation with the Brazilian Submarine Company touching this Company's claim of £6,000 a year, and the question of the control of the tariff, which the Brazilian Submarine Company had claimed, the whole matter had been decided in their favour, with costs. As the shareholders were aware, the Government had given notice to acquire the Company's lines under the original concession, and the Legislature had passed an Act, which had been duly signed by the President, and had become the law of the country. Negotiations and arbitration would in due time be begun in Brazil, and the shareholders would have to await the outcome with what patience they might. Governments did not, as a rule, move with lightning speed, and it was not likely that a question of this magnitude would prove to be an exception.

The motion was seconded by **Mr. C. W. Earle**, and carried unanimously.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Braila.—Tenders are invited by the municipal authorities of Braila, Roumania, by June 17 (29), for lighting the town by gas and electricity. Security required, 25,000f.

London, E.—The Shoreditch Vestry invite tenders for the wiring of the Town Hall We have already given particulars. Tenders must be sent in by 10 a m. to-day.

Manchester.—Tenders are invited by the Paving, Sewering, and Highways Committee for laying a system of underground telephone pipes, etc. We have already given particulars. Tenders must be sent in by to-day.

Brighton.—Tenders are invited by the Corporation for the preparation, supply, and delivery at Brighton of cast-iron lamp pillars and copper canopies for electric light arc lamps by to-morrow (June 1). We have already given particulars.

Godalming.—The Town Council invite proposals for the installation of the electric light for public and private lighting within the borough. Further particulars may be obtained upon application to Mr. Samuel Welman, borough surveyor, Church-street, Godalming.

Grimsby.—Tenders are invited for the lighting of the public streets for one year, for the Urban Sanitary Authority. Forms of tender, copy of specifications, and any further information may be obtained on application to Mr. Marshall Petree, borough surveyor, Town Hall. Tenders, sealed and endorsed "Tender for Street-Lighting," to be delivered at the town clerk's offices, West St. Mary's-gate, by 5 p.m. on June 7.

London, E.C. - Tenders are invited by the G.P.O. for the purchase of about 35 tons of old copper (wire, plates, etc.), a large quantity of other metals (brass, zinc, iron, and steel), india-rubber-covered wire, mercury deposit, indiarubber, tinfoil, felt, rope, tar barrels, raw hide pieces, etc. A form of tender can be obtained from Mr. Charles E. Stuart, controller of stores, G.P.O., Telegraph-street, E.C. Tenders will be received until Monday, June 17.

Huddersfield. — The Electric Lighting Committee of the Huddersfield Town Council invite tenders for high and low tension cables, and transformers, complete in cast-iron cases, with switches, fuses, and covers, required during the ensuing twelve months. Specifications and form of tender may be obtained on application to Mr. A. B. Mountain, borough electrical engineer, St. Andrew's-road, Huddersfield, to whom tenders are to be sent not later than the 1st June, endorsed "Tenders for Cables and Transformers."

York.—Tenders are invited for the following articles during six months ending December 31, 1895, delivered carriage paid at the stores at York, for the North-Eastern Railway Company: (1) telegraph apparatus; (2) telegraph wire and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash, less 2½ per cent discount. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent to Mr. C. N. Wilkinson,

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secretary, York, sealed, and marked "Tender for Telegraph Stores," by noon on June 10.

London.—The Secretary of State for War gives notice that purchases for specific quantities of various articles will be made from time to time during the current year. Among them are electrical instruments for submarine mining and telegraph cable and wire. Manufacturers who may be desirous of tendering should apply to Mr. G. Lawson, director of army contracts, War Office, Pall-mall, S.W., by letter, giving at least names of two well-known firms or public bodies who have purchased from them and are in a position to certify as to the quality of their productions. Applications unaccompanied by references will not be noticed. Firms whose names are already on the War Office list need not apply, as forms for tendering will be sent to them in due course.

RESULTS OF TENDERS.

Hanley.—The Corporation have accepted the following tenders: Condenser for electric light station, Messrs. W. H. Allen and Co., £755; boilers, electric light mains, etc., Messrs. H. and T. Danks, Oldbury, £1,060.

Cardiff.—The following tenders have been received for bottling stores, extension of brewery and electric lighting, County Brewery, Cardiff, for Messrs. William Hancock and Co., Limited. Messrs. J. P. Jones, Richards and Budgen, and C. Jones are the joint architects:

Stephens, Bastow, and Co., Limited, Bristol	£13 250
Knox and Wells, Cardiff	13,105
H. Davies, Cardiff	12,987
J. Allan, Cardiff	12,947
Lattey and Co., Cardiff	12,898
E. Turner and Sons, Cardiff (accepted)	12,648
A. Berridge, Cardiff	12,458

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,712.

Leigh.—The Council's Electric Lighting Bill has been ordered to be reported to the House of Commons.

Snowdon Mountain Tramroad and Hotels Company, Limited. The subscription list closed on Wednesday.

Llandudno.—The District Council's Electric Lighting Bill has been ordered to be reported to the House of Commons.

Brazilian Submarine Telegraph Company.—The directors have declared a quarterly interim dividend of 3s. per share payable on June 22.

Hastings.—Mr. W. J. Lester has completed the erection of a chimney stack, 156ft. high, in connection with the local electric light company's station.

Rio de Janeiro.—News dated 4th inst. from Rio states that the electric light was inaugurated in the locomotive shops of the Central Railway the previous day.

Pontypool.—The Electric Lighting Bill of the Pontypool Electric Light and Power Company has been ordered by Mr. Mellor to be reported for third reading.

Alderley Edge.—The Electric Lighting Bill of the Council has come before Mr. Mellor as an unopposed measure. The Bill has been ordered to be reported to the House of Commons.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 26th inst. amounted to £1 135, as compared with £874 in the corresponding week of last year.

Carlisle.—The Bill embodying the provisional electric lighting order granted by the Board of Trade has been ordered to be reported for the third reading in the House of Commons.

Radcliffe.—A Bill to confirm the provisional electric lighting order has come before Mr. Mellor, chairman of Ways and Means, in the House of Commons. The Bill has been ordered to be reported to the House.

Storage Batteries.—We have received from the newly formed D. P. Battery Company, Limited, 66, Victoria-street, Westminster, a price-list of the well-known "D. P." storage batteries, which have been largely used in the United Kingdom for the past six years.

Harrow.—The District Council have received a letter from the Board of Trade forwarding a copy of revised regulations governing the supply of electric light, and asking for the Council's observations if they desired to make any. No action was considered necessary.

Barnet.—A meeting of the Urban District Council has been held. Messrs. Vaughan and Brown, of Kirby-street, E.C., wrote asking permission to put before the Council a well-prepared proposal for carrying into effect the provisional order *re* electric lighting. The letter was referred to a committee.

Isle of Man.—The electric railway to the summit of Snaefell Mountain is being rapidly proceeded with, and is expected to be ready for July. The overhead system will be adopted and when completed there will be a complete stretch from Douglas to Laxey thence to Snaefell, of about 10 miles.

Harrington Electric Light Company, Limited.—This Company has been registered, with a capital of £3,000, to enter into an agreement, made May 10, with William A. Whiteley, and to carry on at Long Eaton, Derbyshire, the business of an electric light and power company in all its branches.

Agricultural Hall.—The private electrical installation of incandescent lamps for the Royal Military Tournament at the Agricultural Hall, Islington, is being supplied from direct-coupled gas-engines of the Dawson Gas-Engines Syndicate's high-speed type, running at a speed of 660 revolutions per minute.

Liverpool.—A meeting of the Special Lighting Committee of the Corporation was held on Monday, at which it was reported that the draft agreement for the purchase by the Corporation of the Liverpool Electric Supply Company's undertaking was still under the consideration of the directors of the company.

Clifton.—A meeting of the parishioners has been held to consider the question of the proposed renovation of St. John's Church, Clifton. The vicar, the Rev. A. C. C. Anstey, who presided, stated that the matter of electric lighting had been introduced, but that seemed to drop, as they had not sufficient information about it.

City and South London Railway.—The returns for the week ended May 26 were £884, compared with £931 for the corresponding period of 1894, being a decrease of £47. The total receipts for the current period of the present half-year are £19,604 against £19,144 in the corresponding period of 1894, an increase of £460.

Chester.—A meeting of the Electric Lighting Committee has been held, at which it was resolved to recommend the Council to accept the contract of Messrs. Parker, Limited of Wolverhampton, to provide the city with an installation of the electric light. If the Council approve of the recommendation, the work will be proceeded with without delay.

Telephone Catalogue.—We have received from the Electrical Company, Limited, 122, Charing Cross-road, an illustrated catalogue of their telephones. Among the sets dealt with are the students' telephone, without bell; the domestic telephone set, with bell; micro-telephones, with and without bell; desk set; portable set, with hand microphone and bell; and magneto-induction sets.

Hanley.—The Town Council have held a meeting, at which the Electric Lighting Sub-Committee recommended the acceptance of the tender, amounting to £755, of Messrs. W. H. Allen, Sons, and Co., for the supply of a condenser required at the electricity works. Mr. Cottam, electrical engineer, tendered his resignation, having obtained an appointment at Hampstead, and this the sub-committee accepted.

The Telephone in Aberdeen.—The National Telephone Company has 1,029 subscribers in Aberdeen, and 866 exchange subscribers. On 3rd inst. the number of local messages was 15,054, and in more than 14 out of every 15 cases effective communication occupied less than half a minute. At the central exchange the average daily number of local messages in the counting week in March was 11,996, or 14 per subscriber, the mean cost for each message being ·37d.

Nottingham.—We understand that, although, as is natural in this bright weather, the demand is somewhat slack now, since the public supply was commenced at Nottingham there have not been a single cause of failure. There have been no complaints, and the current has been supplied uninterruptedly from that time to the present. The accounts show that the income, after allowing for interest and repayment of loan, is within a couple of hundred pounds in the half-year of a complete balance.

Great Northern and City Railway.—The Unopposed Bill Committee of the House of Commons on Tuesday passed the Bill which gives to the Great Northern and City Railway Company an extension of time until 1900 within which to construct their authorised electric railway from the Canonbury branch of the Great Northern Railway, near Finsbury Park, to the City. The attempt to change the motive power from electricity to steam proved unsuccessful, in consequence of the Standing Orders Committee refusing to dispense with the necessary orders.

New Mains.—The Highways Committee of the London County Council reported on Tuesday that they had considered a notice from the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, of intention to lay mains in Tooting High-street, Balham road and hill, Clapham Common, High street, Pavement and Old Town, Streatham Hill, High road and common, Upper Richmond-road, Kingston-road, East Hill, Trinity-road, Putney Hill, and High-street; with 48 crossings at various places. The details supplied by the company are insufficient, and until further information shall have been supplied, the committee think the Council should withhold its sanction to the works. They therefore recommended that the Council do formally disapprove the works referred to in the notice.

Newcastle-on-Tyne.—There is to be no buying up of existing electric light companies on the part of the Newcastle Corporation. The Electric Light Committee have carefully considered Prof. Kennedy's recent report, and have come to the conclusion that they cannot recommend the Council to purchase existing rights. While they have taken this action, however, the members of the committee have not abandoned the idea of a corporate electric light supply. The town clerk of Newcastle has been instructed to make enquiries on the matter, and the committee will afterwards consider the advisability of getting the Council to apply for powers to provide an independent supply. They pay something like £14,000 per annum to the gas company alone for lighting, and this in itself, it is contended, would furnish a large return for money expended to begin with

Edinburgh.—The Free Assembly Hall is the first of the large halls in Edinburgh to be lighted by electricity. The current has

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been obtained from the Corporation service lines in the Lawn-market, and the installation has been completed by Messrs. Smith and Co., electrical engineers, George-street. It is on the three wire system, and provides seven switches—six of which control the lights in the hall and one the corridor lamps. The roof is studded with 40 incandescent lamps, of which 12 are 50 c.p., 18 32 c.p., and 10 are 16 c.p. At a meeting of the Electric Light Committee of the Town Council a requisition was received from inhabitants of the Stockbridge district requesting an extension of the electric light for private purposes to the Water of Leith Bridge. The necessary guarantee being forthcoming, the committee resolved on the extension, which will cost about £1,200.

Oriental Electric Light Company.—"We," says the *Bangalore Daily Post*, "are much pleased to see the very energetic and successful efforts on the part of Mr. Simpson in the Bangalore business, in obtaining the high patronage of the British resident of Mysore for lighting the residency with the electric light, and this would alone lead, we are sure, to the lighting of the several most important places in Bangalore shortly. We are glad to know from the papers before us that the Company are about to establish an agency in Madras and Ooty, under Mr. Simpson's management, and we are almost certain that this will be a success. We learn from the credentials from Messrs. William Watson and Co., bankers and agents, Bombay and London, that Mr. Simpson is directly connected with the Company in London and is also a partner, and has the entire working and management of the Company's business in India under their direction."

Ayr.—A meeting of the Town Council has been held, when it appeared from a minute of the Electric Lighting Committee of May 23 that the Board of Trade had given their provisional approval of the system for the supply of energy subject to certain regulations and conditions for securing the safety of the public, and for ensuring a proper and sufficient supply of energy. The clerk submitted a communication from the Board of Trade, dated 10th inst., anent a revision of the regulations, and the meeting remitted them to Mr. Hammond, who intimated that he had been charged by several other corporations to report regarding them, and that he intended submitting one report to the Board and to send a copy thereof to each corporation. The clerk was instructed to point out to the Board the recent approval of the present regulations. The Council also decided to extend the electric mains round by Miller-road and Alloway-place while the present contractors are at work.

Telephone Transmitters.—In the year 1878, the late Rev. Henry Hunnings, curate of Bolton Percy, near York, accidentally discovered the wonderful effects produced in a closed battery circuit by a small quantity of loose granulated carbon between conductors, and upon these effects the "talking" power of the Hunnings' telephone transmitters depends. Very shortly after his discovery the rev. gentleman brought it to Mr. Cox-Walker, M.I.E.E., then living at York, who gave it his immediate attention. We are informed that although the utility of the transmitters as commercial instruments was denied by leading electricians, Mr. Cox-Walker's faith in them remained unshaken. A patent was obtained, and, after much experimenting and many disappointments, he and Mr. Hunnings succeeded in making powerful and reliable transmitters, and Mr. Cox-Walker established a factory in Darlington for their manufacture and sale in conjunction with a new telephone receiver of exceptional power, which he had also then invented. Messrs. Cox-Walkers, electricians, of Darlington, have made great improvements in the transmitters recently, and are manufacturing large numbers for all parts.

Coventry.—A meeting of the Town Council has been held, at which Mr. West said at the last meeting of the Council the members were anxious to get all information available as to the Electric Light Committee and their doings. It was seen by the committee's report that it was proposed to extend the mains along Warwick-road, several residents near the chapel being anxious to be supplied with the light. He had no doubt that possibly the Reform Club might see the necessity of having a little more light themselves. Respecting the water-main in Sandy-lane, that was a precautionary measure. When the canal was emptied, it would be necessary to get water from somewhere for condensing purposes. Mr. Hammond, the engineer, had been to Leeds and inspected the plant. He found it in a very forward state, and if necessary the whole of it might be delivered in Coventry three weeks hence. The engineer hoped that the light could be supplied to the citizens in about three months from the present. Mr. Ram told him that the roadway was up that day for putting in the transformers, etc., positively for the last time. The minutes of the Electric Light Committee were then confirmed.

Electric Railway from Derby to Ashbourne.—The Derby *Daily Telegraph* states that a scheme for the construction of an electric railway from Derby to Ashbourne is in contemplation. At present, as visitors to the interesting little town on the banks of the Dove are often painfully aware, it is dependent solely in the matter of railway accommodation on the North Staffordshire Company, by whose roundabout route the journey occupies three times as long as would be the case by a direct service. Mr. John Shaw, jun., acting for some local gentlemen, has been engaged for some time past in working up the scheme, and we understand that the negotiations are so far advanced that the details will be placed before the public during the next few weeks. The route which it is proposed to take will follow pretty closely the course of the present highway through Kirk Langley and Brailsford. A direct railway between the two towns is no new project, the last attempt of the kind having been made during the mayoralty of the late Sir Abraham Woodiwiss. Now that it has been decided to employ electricity, the scheme will possess additional interest to the engineer, inasmuch as it will be the largest electric railway in the United Kingdom.

Thurmaston.—A meeting of the Urban District Council has been held at which Mr. Lavender attended, on behalf of the Wigston Electric Lighting Company, and submitted an estimate for the lighting by electricity of the village. For the lighting of the streets by arc lights he had made an approximate estimate of £1,000 and the annual cost of working and maintenance he put down at £189. The present cost of gas at 4s. 2d. per thousand was £72. 16s., but on adopting electricity instead of the 240 c.p. which they had at present the electric light would give them 10,500 c.p. The approximate estimate of an installation for private use with incandescent lights was £2,000, and on the basis of 500 lights the annual costs would be £331. He pointed out that the profit of the private supply could be devoted to defraying the cost of the public supply. Mr. Blount thought the matter should be deferred for the present. An expenditure of £3,000 was a rather serious item, and they ought not to embark on such a scheme without the sanction of a town's meeting. They could not reasonably expect people to discard the use of gas until they were certain electricity would be better and cheaper. It was decided to defer the matter for three months.

Bournemouth.—It is stated in a local paper that on Friday morning an accident occurred in an underground chamber, belonging to the Bournemouth Electric Supply Company's system, which is beneath the pavement in Glen Fern-road, Old Christchurch-road, to a man named William Spicer, of Winton. Spicer has been engaged for a considerable time by the company, and thoroughly understands the work in which he was on Friday engaged. A new transformer had been lowered into the chamber, and the accident happened during the handling of the cables the current not having been turned out of the circuit as is customary in such a case. Spicer received a number of successive shocks, which for a time prostrated him. His shouts were heard by many persons in the neighbourhood of the transformer, and one of his fellow-workmen, in trying to lift Spicer, himself received several shocks and was obliged to relinquish his hold. After a short time, however, Spicer was moved from immediate contact with the cable, and with the aid of ropes was lifted to the surface of the roadway. His boots were removed, and it was found that his feet and hands were blistered. He was removed to his home and attended by doctors, but was found to have sustained no very serious injury.

Appointments.—The Victoria Institute Committee of the Worcester Corporation intend to appoint a science master of the institute. Salary £200 per annum. The person appointed will be required to give the whole of his time to his duties. The work of the institute will include that of organised science day and night schools, and other day classes, as well as evening classes in technology and commercial subjects. The appointment will date from July 31. Applications, stating age, subjects in which qualified, and teaching experience, together with three testimonials of recent date, must be delivered by June 4, addressed to the Secretary, Victoria Institute, Worcester.—The Liverpool Salvage Association require a practical engineer to act as superintendent in charge of steam pumps, engines of wrecking steamers, and incidental wrecking machinery including electric installations, etc., to take charge of the working of same, and to do any other work which may be required. Salary £150 to £200, with extra allowance if employed on special or foreign service. Applications, stating age and experience, and enclosing copies of testimonials, must be addressed by June 10 to the Chairman, Liverpool Salvage Association, A 20, Exchange-buildings, Liverpool, and endorsed "Application for Engineer."—The Walsall Corporation want a fitter at £2 2s. at week to attend to the engines, boilers, pumps, and dynamos at their central electric light station, and a competent man as battery man and jointer at £1. 15s. a week.

Islington.—A meeting of the Vestry has been held, at which a report was received from the Public Health Committee, stating that it has had under consideration the drainage of 3 Burnard-place, which is the property of the Vestry, and which has been redrained without an inspection-chamber being constructed, as required by the regulations of the Vestry; and that as the attention of the Electric Lighting Committee has been drawn to the matter without effect, it recommends that the Electric Lighting Committee be instructed to comply with the regulations of the Vestry. Mr. Ansell moved the adoption of the report. Mr. Lambert said the Electric Lighting Committee had had no quarrel with the Public Health Committee. The drainage of the house was wrong, and Mr. Barber, the surveyor, was called in, and he said it must be reconstructed. The house was placed in a sanitary condition. The Electric Lighting Committee considered that the chamber was unnecessary. If the Vestry insisted that the chamber should be constructed, it would be done, but he declared it was a wilful waste of public money. The houses would be pulled down in less than two years, and upon the site the electric lighting works would be extended. Recently a sum of £20 had been expended upon them, and the rental was 10s. a week. Mr. Dryden said the Electric Lighting Committee had not a leg to stand upon. Were the Vestry going to decline to do that which they compelled private owners to do? After some discussion, the report was adopted.

Strand.—A meeting of the Strand Board of Works has been held, at which a prolonged and occasionally somewhat heated discussion took place on a report of the Joint Works, Wharf, and Lighting Committees dealing exhaustively with the subject of the supply of electricity for lighting the Strand. More than a year ago the Charing Cross Electricity Supply Corporation made an application for a provisional order to supply the Strand district with electric light. That application was not favourably enter-

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tained, but that of a competing company—the Metropolitan Electric Supply—which offered better and cheaper terms, met with more favour. The subject has been debated in committee and at the ordinary meetings of the Board for the last 12 months, the view generally taken being that there should be, in this matter of electric lighting, effective competition for the whole district The joint committees, having given a long history of the negotiations with the two companies concerned, now recommended that it was not desirable, in consequence of the constant and extensive interference with the streets and foot pavements, of which the Strand tradesmen and shopkeepers complained as being injurious to their business, to support the application of the Charing Cross Company for a provisional order. and that a petition to Parliament in opposition to the company's Bill be lodged. The opinion of the Board seemed about equally divided as to the expediency of adopting the committee's report and rescinding former resolutions in favour of the Charing Cross Company's application. In the result the report was referred back to the committee for further consideration.

Empire of India Exhibition.—The arc lighting of this exhibition at Earl's Court is carried out by means of six of the latest type of Brush series dynamos each designed for 55 lights at 800 revolutions, and the regulation is effected by Brush-Geipel regulators of the most recent water-resistance pattern. The incandescent lighting plant consists of Mordey alternators of the new type, having a joint capacity of 350 kilowatts, which embody all the latest improvements. Two of the alternators have an output of 100 kilowatts each, and run at 325 revolutions with a periodicity of 130; they are coupled to the engines by means of Raworth's patent flexible couplings. There are also two 75-kilowatt alternators running at 355 revolutions and with a periodicity of 130; one of these is direct coupled to its engine, and the other driven by belt. The exciting plant is in triplicate; there is a direct-coupled exciter on each of the alternators, and, in addition, two 25-kilowatt 105-volt compound-wound machines of the Brush-Vienna type, driven by belts off separate engines. The alternator and exciter boards consist of marble panels with the usual Brush Company's switches and instruments. They are also fitted with double-pole change-over switches for throwing either of the alternator fields on to the common exciter omnibus bars, or for connecting each alternator to its own independent and direct-driven exciter. The arc-lighting board is arranged for six dynamos and five circuits, with hook and stirrup pattern switches. The transformers are of the Mordey-Victoria type, having a joint capacity of 276 kilowatts, the majority having an output of 12 kilowatts. All are provided with earth shields between primary and secondary.

St. Pancras.—The Vestry have held a meeting at which Mr. John Hunt called attention to the decision of the Vestry to construct an electric sub-station in St. Andrew's Gardens, Gray's-inn-road, and raised the question whether the provisions of the Metropolitan Open Spaces Act, 1881, did not prevent the Vestry from taking this course. He moved that the Parliamentary Committee be instructed to report on the matter. Mr. Squibb seconded the motion, which was supported by Mr. Clements. Dr. Smith considered that as the piece of ground in question had been purchased under the Metropolis Local Management Act, and had never been used for interments, the Act which Mr. Hunt had quoted did not apply at all in the case. Mr. Hunt's motion was defeated. The decision of the London County Council to lend £14,300 for 42 years, on the condition that no further loan should be raised by the Vestry during the currency of that period for the replacement or renewal of any works included in the loan, was again the subject of discussion. Mr. Clements considered that the rate of interest, 3¼ per cent., charged by the Council, was too high, and that as money was so cheap it ought to be borrowed at 3 per cent. He moved that the Finance Committee be empowered to negotiate with the Vestry's bankers with a view to raising a loan by the public issue of bonds in the City at 3 per cent. interest. Mr. Towner seconded the motion, which was lost. Mr. Towner asked whether the Electricity Committee was aware that some of the ventilators were placed in dangerous positions. He referred especially to one at the corner of Mornington-crescent and High-street, Camden Town. Mr. Sweet was of opinion that the ventilator in question was not at all dangerous. The committee had, however, instructed their engineer to view all the ventilators. On Tuesday the London County Council decided to draw a cheque for £14,300 for a loan to the St. Pancras Vestry for electric lighting purposes.

Dover.—A meeting of the Town Council has been held at which a letter was read from the electric lighting company, asking that a small committee of the Council should meet Mr. Bagshawe to arrange the quantity of light which should be supplied to the Town Hall on different occasions, the quantity varying in the various cases for which the hall was required. Councillor Mackenzie thought the old Electric Light Committee should be appointed He did not think there should be an extra charge for the electric light. He moved that a committee consisting of Alderman Pepper, Councillors Thorpe and M. Mowll be appointed. Councillor G. Fry suggested that the committee should settle the matter themselves without any assistance from the Electric Lighting Committee. He supposed there was such a thing as a meter, and they could settle it by that. Alderman Pepper supported the request of the electric lighting company. He pointed out that it would be extravagant to light the whole of the lamps (240), and it was necessary that they should have some information in deciding which should be alight. The Mayor pointed out they had spent £600 on the electric light fittings in the Town Hall, and practically at the present time they did not use them. The charges wanted putting on a proper basis—he did not care what sort of a committee did it, but something should be done. Alderman Peake said the lighting of the hall by gas cost 10s. per night, and it could easily be ascertained what the electric light would cost, as they knew the power of the lamps. He thought there should be a charge for the hall, with the extra charge for lighting by gas and also by electricity. On Alderman Pepper's motion the old Electric Light Committee was appointed, with the substitution of Councillor Chitty for Councillor Brown. An amendment that the committee should consist of the whole Council was moved by Councillor Edwin, but was not seconded, and fell through.

Derry.—A meeting of the Lighting Committee of the Corporation has been held, at which the following report from Mr. Christie, resident engineer, was read: "With the sanction of the Mayor and chairman of the Lighting Committee, I have during the past fortnight had the Guildhall clock lighted each evening by electricity, a temporary connection being made to one of the city mains. I feel sure that if I had more suitable lamps specially made with proper reflectors and connections underground to two currents I could almost entirely overcome all the objections which at present exist with this temporary arrangement—viz, the dark shadow on the lower half of the dials, the clock being in darkness after midnight on alternate nights, and the inconvenient overhead connection from the top of the lamp to the tower window. To light up the clock properly with all the gear complete would cost about £70, as the same connections off the street mains, without any addition, would do for lighting the main hall of the Guildhall I give you the figures for it also at about £80. This would be for four ornamental 2,000-c.p. arc lamps, and would include all the necessary gear for raising and lowering, etc. From Mr. Algeo I find that the annual gas bill for lighting the clock comes to about £70, and the receipts for lighting the Guildhall by gas to some £40 more making a total of about £110 a year, so that for little more than one year's gas bill the necessary plant could be bought outright, whilst the annual cost of upkeep, carbons, etc., would scarcely be felt. The way in which I purpose to put it down, having half the lamps on different circuits, would reduce the chances of failure at any time to a minimum. If you consider the scheme worthy of adoption, it would be well to have it carried out during the summer, as I could then do the work, at odd times, with my own staff without employing any outside assistance. If you desired to light the staircase and corridor by means of two extra arc lamps, the additional cost would be about £30." The report was approved of.

Brighton.—We have previously referred to the error in tendering in connection with the mains required by the Corporation. At last week's meeting of the Town Council, the Lighting Committee submitted a special report to the effect that since the meeting of the Council on the 16th inst., at which the tender of the British Insulated Wire Company for the supply of vulcanised rubber and lead covered and armoured cables for the electricity undertaking was accepted, they had received a communication from the company stating that they had made a mistake in their tender, and asking permission to withdraw their offer for the supply of the cables The committee recommended that the British Insulated Wire Company be allowed to withdraw from the contract, and that the tender of Messrs. Siemens Bros. and Co., Limited (which is the next lowest), be accepted at £289 per mile for three-core cable and £239 per mile for two-core cable. Alderman Moon moved the adoption of this report. He stated that the tender of the British Insulated Wire Company amounted to £230 per mile for three-core cable and £215 per mile for two-core cable, and the difference between their tender and the one which the committee now proposed for acceptance would result in a loss to the Corporation of between £300 and £400 But previous to the company being informed of the acceptance of their tender by the Corporation they wrote to the town clerk to the effect that some mistake had arisen with regard to the thickness of the indiarubber coating of the wires owing to the manner in which the word "radial" had been employed in the specification as defining the thickness of the indiarubber. The effect of the error was that the tender was based on a thickness of $\frac{1}{16}$in. instead of $\frac{1}{8}$in.; and though he (Alderman Moon) thought the clause in the specification clear enough, still, as it was possible to interpret it in the way in which it was stated the company had done, it was felt by the committee they had nothing to do but to release them from the tender. Councillor Berry seconded; and Alderman Moon having assured Councillor Dell of Messrs Siemens's willingness to adhere to their tender, the motion was carried, and the meeting terminated.

Lynn.—A meeting of the Town Council has been held at which the subject of the electric light was brought forward. Mr. Jermyn had, according to the agenda, given notice to move that application should be made for a provisional order for electric lighting. He said this was not exactly what he intended it to be, or sent to the town clerk. He did not bring up that question with the idea of spending any money for new works at the present time, and he had not introduced the resolution with any desire to prefer an attack on the gas company. As far as the gas company were concerned they had always treated him, as a large consumer, with every consideration, but it was a matter that rather affected the town. He did not want a mistake to be made—he spoke of the electric light as the modern light—like the terrible mistake that was made years ago when a private company was allowed to start the gas-works. He did not want a private company to come in and take up what would be a large business, the profits of which should be applied to the borough fund, and of which the ratepayers should have a very large share. He did not know whether the Corporation would take it up, but he would like to approach the Board of Trade for provisional powers during the next three years to put in

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an installation for electric light. That would prevent any private company from taking any advantage. He did not know exactly how to word his resolution, but if he might alter it he would move that they apply for a provisional order giving them leave within the next three years to carry out such works as would be necessary to put in an installation of electric light. Mr. Woodwark seconded. Mr. Rose said the resolution before the Hall was somewhat nebulous. The Board of Trade would want to know something more. There was no doubt that the electric light would be the light of the future, and sooner or later it would come to King's Lynn. He had an idea that they ought to go ahead now. They had been somewhat twitted about special committees, but he would like to see a special committee appointed to make it their business to go into this matter and answer the questions that had been put, and then if deemed necessary to go into the system at once. There were plenty of people only just waiting to adopt the electric light, and if the thing was coming he did not see why it should not be gone on with as soon as practicable. He would suggest that the matter be either referred to one of the standing committees or a special committee. Mr. Jermyn said, with the permission of his seconder, he would ask that the matter should stand over until the next meeting of the Hall, when the town clerk could give them all the information they wanted on the matter. This course was agreed to.

Hampstead.—At last week's meeting of the Vestry, Mr. Thwaites, chairman of the Lighting Committee, moved the adoption of a recommendation from that committee that a chief assistant electrical engineer be appointed by the Vestry. Mr. J. Aitchison moved, as an amendment, that the appointment be deferred until after the arrival of Mr. G. H. Cottam, who, at the previous meeting, was appointed chief electrical engineer at a salary of £300 per annum. Mr. Richardson seconded the amendment. Mr. Underwood explained that it was necessary to have a chief assistant now that the whole of the work had to be done by the Vestry's own staff without the advice of a consulting engineer. Mr. T. Eustace Smith suggested that the appointment should be made temporarily and not permanently. Mr. Hackworth said that the appointment would in no sense be a permanent one, seeing that the official would be subject to a month's notice at any time. Mr. Reed remarked that when the chief engineer commenced his work the chief assistant engineer would be mainly engaged in outside work. The amendment was defeated. Mr. T. Eustace Smith and Mr. Richardson rose together, and the chairman called on the former. Mr. Smith: I think we both rose for the same purpose. I wish to move as an amendment that the word "temporarily" be inserted before the word "appointed." Chairman: Is it worth while to do so? Is it worth while fighting it all over again when you know that you have the matter in your own hands by giving a month's notice? Mr. Smith: I will withdraw the amendment if that is your view. It was decided that the salary of the assistant should be £200 per annum. Mr. Thwaites then moved that Mr. E. Sayer, at present one of the assistant engineers at the central station, be appointed to the office. Replying to some remarks made during the debate, he said it was true that Mr. Sayer had received the offer of another appointment, but had expressed his desire to remain at Hampstead if his position were improved The Electric Lighting Committee had every confidence in his ability, and had placed him in command of the station until the arrival of the new chief. This motion was carried. The Lighting Committee reported that they had appointed a temporary assistant engineer at the station, at a salary of £2 per week (the appointment being subject to one week's notice), until such time as the chief electrical engineer should take up his duties. This was approved of. The Lighting Committee recommended that the necessary substation, feeder, and distributors for the private lighting of Haverstock-hill, from Belsize-grove to Eton-road, be laid down at an estimated cost of £892, and that a high-tension main for private lighting be laid down from sub-station 6A, in Heath-street, to the corner of Redington-road, at an estimated cost of £294. This recommendation was approved of.

Transformer-Chambers.—The Highways Committee of the London County Council on Tuesday reported that on February 12 last, the Council, in giving sanction to certain of the works referred to in the notice of the House-to-House Electric Light Supply Company, expressly withheld sanction to the construction in Kensington High-street of a transformer-chamber of the inside dimensions of 5ft. by 6ft. 6in., and between 6ft. and 7ft. deep. The company gave notice on May 14 that, as its system of supply had received the provisional approval of the Board of Trade, it intended to proceed with the construction of the transformer-chamber; and by the direction of the committee the Council's solicitor warned the company that as it had not appealed to the Board of Trade it had no authority to proceed with the work. The company has since intimated its intention to appeal; but has also, with the view of meeting the objection of the Council, offered to place the proposed chamber in Wynnstay-gardens, a position which is certainly less objectionable than that first proposed. The Council has consistently objected to the construction of large transformer-chambers under the public thoroughfares, and the committee do not see any reason for an exception being made in this case. They therefore recommended that the House-to-House Electric Light Supply Company be informed that the Council is not prepared to depart from its decision withholding sanction to the construction of the transformer-chamber referred to in the company's notice, dated January 21, 1895, or to sanction the construction of the chamber in the alternative position in Wynnstay-gardens, shown upon the plan submitted with the company's letter, dated May 22, 1895; and that consequently the Council leaves the matter for the decision of the Board of Trade upon appeal. The committee considered a notice from the County of London and Brush Provincial Electric Lighting Company of intention to construct 42 transformer-chambers in St. Luke's and Clerkenwell. The Council has repeatedly expressed its disapproval of the construction of transformer-chambers of large size in the public streets, and that being so, the committee think the Council should refuse its sanction to the construction of the chambers referred to in the notice. They recommended that the Council do formally disapprove the works referred to in the notice. Another notice has also been received from the same company of intention to construct 34 transformer-chambers in the Wandsworth district in the positions shown upon plans submitted with the above-mentioned notice. The Wandsworth District Board entertains with the Council a very strong objection to the use of the public streets for these chambers and following the practice hitherto adopted, the committee think the Council should refuse its sanction. They accordingly recommended that the Council do formally disapprove the works referred to in the notice.

Kingston-on-Thames.—The Lighting Committee resolved to inform the authorities of the several places of worship in the borough that it was proposed to supply electric current to places of worship at 4½d. instead of 6d. per unit, but without discount. The Local Government Board having sanctioned the borrowing of £7,772 for 15 years only for electric lighting, a deputation was appointed to wait upon the Board and urge that the full amount of £10,000 be authorised for 25 years. An application from Messrs. New and Mayne, asking permission to lay a pipe across Portsmouth-road to the river, for the purpose of charging electric launches, was refused, as the committee were themselves making arrangements for charging launches. The committee recommended the Council to accept an offer of Messrs. Siemens to supply and fit up the necessary cable, etc., from the electric works to the river for the purpose of charging launches at about £100. The Town Council have approved of the recommendation. Mr. J. E. Edgcome, A.M.I.M E, the borough electrical engineer, has submitted to the Council the first annual report upon the electric lighting station. The revenue account of the works from October 16, 1893, to December 31, 1894 (the period which the report covers), shows a deficit balance of £1,298. 18s. 7d.; the receipts being £1,985. 19s. 7d. (1,116. 0s. 9d. from private consumers, £41. 9s. rental of meters, and £828. 9s. 10d. for lighting 36 arc lamps at £20 per lamp); and the expenditure £3,284. 18s. 2d. This total is thus made up: generation of electricity, £1,921. 13s. 5d.; distribution of current, £296 11s.; rent and taxes, £46. 9s. 8d.; management expenses, £276. 5s. 1d.; special charges, £743 19s. (which includes £711. 14s. 10d. for repayment of principal and interest, and £32. 4s. 2d. for insurance). The total "works cost" per unit of electricity is 4·15d.; the total plus management expenses is 4 754d; and the total including everything is 6·146d. No capital account is furnished. The number of units supplied during the period of 14 months under notice was—to private consumers 44,642, and to public arc lamps 83,625. The charge per unit to private consumers is 6d.; the charge for the arc lamps is about 2½d. per unit. The report continues: "The amount receivable for the sale of current for the first quarter of 1895, ending March 31, is £469. 18s. 10d. It will be seen, therefore, that the receipts for this quarter are more than double the receipts for the corresponding quarter of 1894. This is a very promising outlook for this year's returns. The lamps at present installed by consumers, including those of Town Hall, Corporation Offices, and free library, are equal to 4,150 lamps of 8 c.p. There are 36 arc lamps installed, each of 2,000 nominal candle-power. When first erected these lamps displaced 90 gas lamps, but by rearranging some of these arc lamps during last summer, the number of public gas lamps displaced by these 36 arcs has been increased to 114, the public electric lighting having been extended along London-road to the foot of Kingston-hill, along Richmond-road to Acre-road, and through Eden-street from Clarence street to St. James's-road, thus completing the belt of light in the centre of the town. As the number of private consumers increases (and assuming that for the present the number of public arc lamps will not be increased) so in proportion will the quantity of units sold at 6d. increase as compared with those sold at 2½d., and this of necessity will considerably raise the average price obtained for current above the present average price of 3·638d. per unit. On the other hand, this increased output will tend to lower the average cost price of 6·146d per unit, the average for last year, as the expenses for a large increase of output will not be proportionately as high. For instance, a very small addition to the wages sheet would be necessary to cope with three to four times the present output, whereas such fixed charges as management, insurance, and taxes, would not in any way be increased. Although fuel would to an extent increase in proportion to the amount of electricity supplied, I see no reason why the present average of 2 025d. per unit for fuel should not be reduced to 1·1d. or 1 2d. per unit sold, or even less, especially if we can obtain customers to use current for cooking, heating, and motor purposes, which will help the day load, at present a very small one, but for which it is necessary to keep machinery running to meet any demand which may arise during the whole of the 24 hours. When in this manner the cost of production shall have fallen and the average price obtained have risen until they are equal, the works will be self-supporting, and beyond that point they will become a profitable and paying manufacturing business, and the profit so obtained could be applied to lowering the ordinary lighting rate upon the borough. The returns of the first year's working show conclusively that the whole question of profit earning in an undertaking of this kind is

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merely one of sufficient demand. It must be obvious to the ratepayers that the desired result of converting what is at present a burden upon the rates into a profit earning undertaking for the benefit of the borough lies entirely in their own hands, and that such a result will be obtained when the demand for current has sufficiently increased. It must therefore be to the interest of every ratepayer to endeavour to bring about this desired result."

PROVISIONAL PATENTS, 1895.

MAY 20.

9919. **Heating body for electric soldering irons.** Friedrich Wilhelm Schindler-Jenny and Paul Stotz, 89, Chancery-lane, London. (Complete specification.)

9937. **Improvement in the manufacture of active material for secondary batteries.** Siegfried Hammacher, 31, High Holborn, London. (Complete specification.)

9939. **Improvements in or relating to electric railways.** Antoine Léon Robton, jun., 323, High Holborn, London.

9961. **Improvements in connection with laying submarine electric cables.** Charles Scott Snell, Culver Park, Saltash, Cornwall.

9966. **Improvements in or relating to electric arc lamps.** Albert Lewis Davis, 70, Chancery-lane, London.

9967. **Improvements in electric regulators.** Harry Neville Moody, 70, Chancery-lane, London.

9969. **Improvements in dynamo-electric machinery.** Horace Field Parshall and the British Thomson-Houston, Limited, 70, Chancery-lane, London.

MAY 21.

9981. **The application of the motor-generator for purposes of electrolysis.** Alfrest Ernest Old, 66, Stanmore-road, Edgbaston, Birmingham.

9997. **Improvements in the application of electrical energy to the heating of air or other gaseous bodies.** Robert Cattley Jackson, 4, Framlington-place, Newcastle-on-Tyne.

10027. **Improvements in telephonic installations for increasing the strength of the transmitted sounds.** Anton Hamm, Gergely Blank, Victor Brandt, and Gyula Körmendy, 28, Southampton-buildings, Chancery-lane, London.

10029. **Improvements in pendants or electroliers for electric lamps.** John Webb Singer, Walter Herbert Singer, and Edgar Ratcliffe Singer, 40, Chancery-lane, London.

10052. **Improvements in electric railway signals.** Henry Valentine Miller and Alexander Cicero Miller, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1058. **Improvements in or appertaining to electrically-illuminated advertisements, signs, and like devices.** George Frederick Kenyon, 27, Kirkgate, Bradford.

MAY 22.

10114. **The Galvanopile, an improved form of galvanic battery.** Richard Joseph Crowley, 10, Harbour-row, Queenstown.

10134. **Improved means applicable for use in the decomposition of substances susceptible to electrolytic treatment.** George Gatton Melhuish Hardingham, 191, Fleet-street, London. (Rudolf Langhans, Germany.)

10142. **Improvements in electric gas-lighting devices.** James Tarbotton Armstrong, 45, Southampton-buildings, Chancery-lane, London.

10154. **New or improved electrical attachment for drinking-vessels.** George Gregory Smith, 54, Fleet-street, London.

10155. **Improvements in or relating to telephone systems.** Moise Freudenberg, 45, Southampton-buildings, Chancery-lane, London.

MAY 23.

10241. **A novel construction and arrangement of appliances for generating electricity.** Alfred Launcelot James Tait, and Walter Henry Pearson, 166, Fleet-street, London.

MAY 24.

10249. **Improvements in and connected with multiple switch-boards for metallic circuit.** Hermann Oppenheimer, 55, Redcross-street, London. (Actien Gesellschaft Mix and Genest, Germany.)

10250. **Improvements in or relating to electric bells, signals, and other means of electrical communication.** Thomas Sloper, 11, Brittox, Devizes.

10277. **Improvements in apparatus for measuring electrical currents.** Siemens Bros. and Co., Limited, and Edward Friedrich Hermann Heinrich Lauckert, 28, Southampton-buildings, Chancery-lane, London.

10284. **Improvements in the manufacture of incandescent or glow lamps.** Charles John Peach Robertson, 6, Bream's-buildings, Chancery-lane, London.

10308. **An improved electric lock.** Louis Defert, 40, Chancery-lane, London.

10302. **Improvements in connection with laying submarine electric cables.** Charles Scott Snell, Culver Park, Saltash, Cornwall.

10304. **A method of generating a current of electricity during the revolution of a carriage or car wheel.** Walter Henry Pearson and Alfred Launcelot James Tait, 45, Holborn-viaduct, London.

10313. **Improvements in effecting telegraphic or telephonic communication through submerged cables, and in the construction of cables to be used for this purpose.** Willoughby Statham Smith and William Puddicombe Granville, 24, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1891.

17426. **Generating ozone by electricity.** Andreoli. (Second edition.)

1894.

6458. **Dynamo-electric machines.** De Ferranti.

8825. **Conducting electricity through table-cloths, etc.** Electrical Installation Company, Limited, and O'Brien.

9368. **Electric fuses.** Brain.

10353. **Electric lamp, etc., fittings.** Morris.

10952. **Electrodes.** Hoepfner.

12221. **Electrical furnaces.** Justice. (Acheson.)

12650. **Storage battery plates.** Drake and Gorham.

12982. **Arc lamps.** Brockie.

13267. **Galvanometers.** Hopkinson.

14691. **Motors.** Lake. (Cie de l'Industrie Electrique.)

17741. **Galvanic batteries.** Thompson. (Lessing.)

1895.

4939. **Electrolysis.** Andreoli.

5568. **Arc lamps.** Thompson. (Mathiesen.)

6163. **Voltaic battery plate.** Buckland.

6430. **Electric conduits.** Cummings and Yawkey.

6652. **Electric accumulator plates.** Duffek and Holub

6781. **Electric glow lamp socket.** Edison and Swan United Electric Light Company, Limited, and Proctor.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5¾
Brush Company, Ordinary	3	2¾-2¾
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2½
—— 4½ Debenture Stock	100	113-116
Charing Cross and Strand	5	5½-5¾
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	15½-16
—— 5 per cent. Debenture Stock	100	133-136
City and South London Railway, Consolidated Ordinary	100	44-46
—— 4 per cent. Debenture Stock	100	131-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	—
Electric Construction, Limited	2	¾-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1½
Elmore's Wire Company	2	1½-1¾
Fowler-Waring Cables	5	¾-1½
W. T. Henley's Telegraph Works, Ordinary	10	10-11
—— Preference	10	13½-14½
—— 4½ per cent. Debentures	100	101-104
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7½-7¾
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	103-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7¼
Liverpool Electric Supply, Ordinary	5	7¼-7½
—— Pref.	—	—
Liverpool Overhead Railway	10	9½-9¾
—— Pref.	10	14½-15½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	¾-1
Metropolitan Electric Supply	10	10½-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	5¾-5¾
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Nom. Cum. Third Pref.	5	5¼-5½
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	8-8½
Oriental and Electric Company, £1 shares	1	1-1⅛ xd
—— £5 Shares	5	7-7½ xd
—— £4½ shares	4½	5¾-6¼ xd
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8¾
—— 7 per cent. Pref.	5	8½-8¾
Swan United Ordinary	3	1½-1¾
—— 4½ per cent. Debentures	100	105-106
Telegraph Construction and Maintenance	12	42-47
—— 5 per cent. Bonds	100	109-111
Westminster Electric Supply, Ordinary	5	3½-4
Yorkshire House-to-House		6½-7

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NOTES.

Obituary.—The death, at Chester, is announced of Mr. William Clarke Deeley, chairman of the Electric Lighting Committee of the Chester Town Council.

Electric Lighting in India.—The Government of Bengal is preparing a Bill to facilitate and regulate the supply of electricity for lighting, etc., in Calcutta.

Another Alpine Railway.—Herr T. Schenkl, of Graz, has received official authority to proceed with the plans for the construction of an electric rack railway up the Grossglockner.

Recognition of Reis.—It is announced that the German Emperor has directed that an annual pension of 400 marks shall be paid to the daughter of Philip Reis, the inventor of the telephone.

Cables in the North.—H.M. telegraph steamer "Monarch" has arrived at Kirkwall. She is to be engaged in laying cables between Fair Isle and Shetland and from Rousay to the mainland.

Electric Lighting in Camp.—The 1st Monmouthshire Artillery Volunteers at Whitsuntide camped out at the old Roman encampment near Port Skewitt. The electric light was used for lighting the camp.

Projected Zinc Ring.—According to the German papers, negotiations are proceeding between Rhenish and Belgian works for the establishment of a convention to control both the production and price of zinc.

The Jeantaud Electric Stage Coach.—*Le Vélo* gives an account of the electric stage-coach service between Paris and Bordeaux which M. Jeantaud has organised. The current is obtained from Fulmen accumulators.

Electric Transmission in South Africa.—Additional power is being used in connection with the Sheba electrical transmission plant, and stone-crushers and some of the stamps have been running for experimental purposes. The full power will, it is expected, be available shortly.

New Indian Telegraph Line.—The Government of India, in the Public Works Department, have recently sanctioned the recommendation of the Director-General of Telegraphs, that an allotment of one lakh of rupees may be made for constructing the line from Mone to Kengtung.

Physical Society.—At the meeting of this society to be held on the 14th inst. papers will be read on "The Measurement of Cyclically Varying Temperatures," by Mr. H. F. Burshall; on "The Thermal Constants of the Elements," by Mr. N. F. Deerr; and on "An Electromagnetic Effect," by Mr. F. W. Bowden.

Not in a Hurry.—There has just come to hand a number of the *Bulletin de la Société Belge d'Electriciens* for the first quarter of the current year. It contains an elaborate paper by M. P. van Vloten, being a report on electric traction in Europe, read by him in August, 1894, before L'Union Internationale et Permanente des Tramways.

A Competition.—The directors of the Great Berlin Tramway Company offer six prizes of respectively 2,000, 1,000, 700, 600, 400, and 300 marks for the six most artistic designs of poles and wall rosettes for electric tramway overhead wires. Plans will be received until June 20 by Die Direktion der Grossen Berliner Pferdeeisenbahn-Aktien-Gesellschaft, Berlin, from whom further particulars may be obtained.

Engineers Wanted in Siam.—At Bangkok the machinery laid down for electric lighting was designed for 12,000 lamp power, and there are not 1,000 lamps in use, because there is no suitable agency at command for guidance and direction. Here, says *Indian Engineering*, is a chance for the competent mechanical engineer. Or he might secure profitable employment in the telegraph department, which is undermanned and vociferous for coefficients.

Telegraph Extensions.—The Postmaster-General has sent a letter to Mr. Weir, M.P., who has been pressing for telegraphic extensions on the western mainland of Rossshire and the Island of Lewis. The Postmaster-General says: "I can assure you that I am fully alive to the importance of setting to work as soon as possible on any extensions which it may be decided to carry out, and I am in expectation that the Scottish Office will soon inform me of its decision in this matter."

Electrical Trade Section.—Notice is given that a meeting of the Electrical Trade Section of the London Chamber of Commerce will be held at the offices of the Chamber on Tuesday next, the 11th inst., at 12 noon, to further consider regulations and conditions for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy made by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888, together with observations made by members of the section in reference thereto.

Telephone Between Dublin and London.—The Lord Mayor of Dublin has been informed by the Postmaster-General that the Post Office Department has now completed the erection of trunk wires between London, Dublin, Belfast, Edinburgh, and Glasgow. The Lord Mayor of London has promised to be present at the London office on Wednesday, 12th inst., at one o'clock, and the Lord Mayor of Dublin has been asked to be present at the same time at the General Post Office at Dublin for the purpose of conversing with his lordship.

English Patents.—It appears from the twelfth report of the Comptroller-General of Patents, Designs, and Trade Marks that last year 25,386 patents, 21,230 single designs, and 8,013 trade marks were applied for, the number of patent applications being the largest in the group, though this was not the case with regard to the other figures. Of the 25,000 odd patent applications, 500, or 2 per cent., were made by women, about 100 being inventions connected with articles of dress. The number of readers frequenting the Patent Office library showed an advance upon the previous year, 113,374 persons having availed themselves of its use.

Electric Lighting of Railway Carriages.—We referred to this subject in our issue of 24th ult., both in our "Notes" and on p. 586, and in our last number on p. 618, and it may be interesting to add that Baurath Staberow has reported to the Railway Society in Berlin that the management of the Dortmund-Gronau-Enscheder line are satisfied, both from a technical and an economical point of view, with the electric light, which was introduced into some of their trains a year ago. Twenty-seven carriages were fitted with 85 incandescent lamps, and the total cost of the charging station, the Tudor accumulators, and necessary buildings was £1,815.

Electric Litigation on the Continent.—The ways of Continental courts of law are slow but sure. Some years ago, the firm of Ganz and Co. won an action against a Tours firm for wrongfully using their system of long-distance transmission with alternate-current transformers, which was patented by them in France. They were likewise victorious when, two years ago, the case came before the Court of Appeal at Orleans, and now this judgment has been confirmed by the Supreme Court of Cassation. An action involving the same point at issue, which Messrs. Ganz and

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Co. brought against Messrs. Siemens and Halske, at Grosseto, in Italy, has also resulted in favour of the Budapest firm.

The Slavianoff Electric Welding Process.—Attention is being drawn on the Continent to the process of electrically fusing metals which M. Slavianoff has invented. It is stated to be analogous to the Benardos method, and that it can be substituted for it with advantage for metallic repairs—to fill up a crevice, restore a chipped corner, etc. The article to be treated is connected to one of the poles of a battery, the bar of metal to be used in the repairs being connected to the other pole. The two electrodes are brought together to form the voltaic arc. The bar of metal melts, and it is so fixed that the molten drops fall upon the place to be repaired. The electrodes must, of course, be made to approach each other as the bar fuses in order to obtain an uninterrupted arc.

The Brussels Exhibition of 1897.—The Commissaire-Général of the Paris Exhibition of 1900 has recently declared to an interviewer that *l'électricité sera un des éléments les plus importants de la grande exposition.* The Société Belge d'Electriciens seems to be equally anxious that at the forthcoming Brussels exhibition electricity shall play an important part. The *Bulletin* of the society thinks that the electrical section of the exposition should be classified as follows: (1) production and mechanical utilisation of electricity; (2) electro-chemistry; (3) electric lighting; (4) telegraphy and telephony; (5) various applications of electricity. It is also suggested that it would be well at the same time to celebrate the jubilee of the establishment of the first telegraph line on the Continent—that between Brussels and Antwerp.

Electricity Supply from Coalfields.—In the course of his presidential address at last week's meeting of the Federated Institution of Mining Engineers, Mr. W. N. Atkinson, Government inspector of mines for North Staffordshire, said that a subject of interest to colliery owners and mining engineers which appeared to be looming in the not very distant future was the establishment of large central installations in coalfields for the distribution of power to distant places by electricity. If this was found practicable there would be an immense saving in the cost of carriage of coal to the consumer, and a mitigation of the smoke plague afflicting so many manufacturing towns. In some cases it might even be to the advantage of colliery owners to initiate the system for the distribution of energy to groups of mines.

Electric Baths from Street Circuits.—It is stated that the employment of street-lighting circuits for electric baths has become quite customary in France. A transformer is used which lowers the potential to from 15 volts to zero. Where only a single bath is to be fitted up, as in a private residence, there is employed a combination in series of a shocking-coil and a small transformer. The whole is placed in a little marble receptacle above the bath. The secondary of the transformer moves along slides, and a rod passing to the outside enables the current to be regulated from a maximum to a minimum strength. The primary circuit is provided with an interrupter. The wires of the secondary proceed directly to the electrodes, which are simple plates of metal that can be placed anywhere in the bath by means of suspending hooks. There is also added an ampere-meter for continuous and alternating currents.

The Telephonic Sound Produced by Thermic Radiation.—M. Semmola has shown (*Comptes Rendus*) that in causing intermittent solar light to fall, by means of a lens, on the gilded metallic plate, 2mm. thick, of a Hunnings microphone, the telephone put in circuit produces a slight but very distinct sound. If the luminous ray be suppressed, the sound ceases. The intensity of the sound increases or decreases according as the intermittences of the radiation become more or less rapid. The best radiations are the thermic radiations, as the sound is louder when the metallic plate is coated with smoke-black. On the other hand, the sound is no longer heard when the luminous pencil traverses non-thermal substances before reaching the microphone. It is necessary that the tiny image of the sun which is formed in the focus of the lens, and which strikes the vibrating plate, should be fairly hot and capable of at least carbonising paper. It seems, then, that the plate suffers rapid and regular dilatations and contractions which determine the thermic vibrations.

Another "Electric Bicycle." — We hasten to chronicle particulars of the electric bicycle of M. Manger ere we are forestalled. This gentleman has taken out a patent for "the adaptation of dynamos, without accumulators, to ordinary bicycles to permit of the production at will of electricity to be used for ascending hills, and in making long cyling journeys without fatigue to the rider." His system "consists (1) of a cogwheel fixed to the pedal axle; (2) of a dynamo engaging with this cogwheel; (3) of a motor capable, if necessary, of communicating its movement by belting to the hind wheel by means of two pulleys. If the dynamo is disengaged and the belting is placed on the loose pulley of the motor, the conditions are the same as in an ordinary bicycle. If, on the contrary, the cyclist is tired or has a hill to climb, all that he has to do is to engage the dynamo with the cogwheel, and to place the belting on the fixed pulley of the motor. Current is generated by the dynamo and transmitted to the motor which connects with the hind wheel, and thus affords powerful aid to the cyclist." It is the same with all great inventions: one wonders why this simple but brilliant idea never occurred to any genius before.

Technical Instruction Conference.—The following letter has been addressed by Sir Henry Trueman Wood, secretary to the Society of Arts, to representatives of technical education committees and others interested in the subject: "It has been suggested to the council of this society that a useful purpose would be served if the society were to afford to those who are interested in technical education in different parts of the country an opportunity of meeting together and discussing the measures which the society might take with a view to enlarge the scope of its present action in this matter and thus aid local authorities in giving effect to recent legislation on the subject. There appears to be a lack of a central organisation which might deal especially with such questions as the examination and inspection of classes. In spite of the valuable work which has been done by the City and Guilds of London Institute and by other bodies, it is only in a portion of the subjects sanctioned as subjects of technical instruction that examinations are held. The wide field of agriculture and home industries is untouched, while no means are provided for anything like a general system of inspection which local authorities may call to their aid should they desire to do so. There are also other points with regard to which common action would be desirable, and the council of the society have, therefore, determined to hold a conference of representatives of the technical instruction committees of the various county councils and others with the view of eliciting their views on the subject. It is proposed to hold this conference on June 20, and to invite to it the chairmen of the technical instruction committees or other representatives who may be delegated by such committees and their directors or organising secretaries. I shall be glad if you will let me know whether you can yourself

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attend the meeting and also whether your county council will depute any members of its technical instruction committee to attend."

Contact Resistance of Metals.—In *Comptes Rendus* M. Edouard Branly describes some experiments recently carried out by him in regard to the electrical resistance between two sheets of metal in close contact with each other. M. Branly employed thin sheets, 48mm. square, piled one on the top of the other and compressed together by a weight of six kilogrammes. Electric connection was made with the column by means of sheets of brass at the top and bottom of the pile of plates. When a sheet of zinc was placed between two of copper, the contact resistance was very small and remained constant; but when a sheet of aluminium was placed between two sheets of bismuth, the resistance was quite appreciable and increased with time. Thus, in one experiment, the resistance was, to start with, 0·4 ohm, and 25 minutes after the contact had been made it was 0·74 ohm, and five hours after it was over three ohms. If the experiment was varied by putting the sheets of bismuth together and separating the aluminium from the bismuth by a sheet of brass, there was no appreciable resistance. M. Branly remarks that his experiments show that for certain metals—such as copper and zinc—the surface of contact is not the seat of any appreciable resistance, but for others—such as lead aluminium, lead iron, tin aluminium, tin iron, bismuth iron, bismuth aluminium, etc.—there is an appreciable resistance. When the six-kilogramme weight was replaced by one of 26 kilogrammes, the resistances at the beginning and the resistances as measured later on were smaller, and the same was the case when the pile of sheets was compressed in a vice, but in all these cases a higher resistance was found than one would have expected according to current notions, and this resistance always increased with time. The contact resistance of two metals in air can, M. Branly states, be altered by mechanical shock or by electric spark.

Telephones and Earthquakes.—The noises which trouble long-distance telephones that use the earth to complete the circuits have been turned to account by Señor Estrada, professor of physics in the Potosi State College, as a means of foretelling earthquakes in volcanic zones. By means of the telephone and microphone, and with daily observations taken in the area including Vera Cruz, Pueblo, Mexico, and Guadalajara, Prof. Estrada believes it possible to definitely forecast earthquakes and volcanic eruptions, as the result of the great interior changes of the earth, which change the geological construction of the land. The sensitiveness of the telephone renders it admirably adapted for recording approaching seismological phenomena, and a rational study of these phenomena is proposed by the construction of various telephone lines. One line would connect the Central Government Meteorological Observatory with the base of the volcano of Popocapetl—being grounded in one of the deepest cracks or crevices, selecting among them one containing a thermal spring—connecting the other end of the line at the observatory with the metallic tube of one of the deepest artesian wells in the city. Another line, he urges, should run from Pueblo to the same mountain, and then connect Guadalajara with the volcano of Colima, and other lines to the peak of Orizaba, the Coire de Perote, and the Jorutle volcanoes. In each of these branches or sections, and with all the lines connected as often as possible without interfering with the service of the wires, Prof. Estrada proposes to place in the observatories at Mexico, Pueblo, and Guadalajara, a simple microphone composed of a pendulum suspended on a thin spiral wire, so arranged as to close an electric circuit at the slightest motion and to set an electric bell ringing, in order to record the slightest movement of the earth. By this means eruptions of any volcano and earthquake may, it is thought, be foretold many days in advance.

Electric Ploughing in Germany.—Practical experiments in electric ploughing have been made at Halle-on-the-Saale, Germany, by Messrs. F. Zimmerman and Co. Here a two-furrow tilting plough was used. The electric motor is fixed to the implement itself. The shaft of the motor, by means of a double spur-wheel gear, drives a shaft fitted with a pinion, over which a chain runs from one end of the field to the other. This chain is held taut at both ends by triple ground anchors. When the motor is put in operation it will haul the plough across the field. When the end of the field is reached the plough is tilted to the other side, and by reversing the motor the plough starts on its return journey, at the same time depositing the chain sideways for the next row of furrows. The anchors are moved by a labourer, who lifts them out of the ground with a hand lever. The current is generated by a portable dynamo and 10-h.p. steam-engine, and the current is conveyed by a cable that follows the car upon light cars, which turn readily in any direction. The power used in the heavy loamy clay at Halle-on-the-Saale was an average of eight kilowatts. The plough turned two furrows, measuring together 60cm. in width by 24cm. in depth, and, travelling at 0·9 metre per second, the actual useful effect was equal to 8 effective horse-power, which showed that there was a loss of about 4 h.p. between the portable engine and the plough. A 16-h.p. engine was used for a four-furrow plough, and the depth of the furrow was 24cm. One of the remarkable features of this system is that, guided by the tightened chain, very shallow furrows can be made with great evenness and regularity, and the balance plough can thus be used for turning over stubble land and other light work. As regards attendance, only one man is needed for the lighter plough, while for the larger one three men are required—a ploughman and a man at each end to shift the anchors. The first cost of an electric plough is said to be much below that of a steam cultivating plant. A steam-plough, with two portable engines, will cost from 40,000 to 60,000 marks, but Messrs. Zimmerman and Co. can supply a four-furrow balance plough, with electric motor and reversing gear, as well as 250 metres of chain, two anchors, 600 metres of insulated cable, and six cable cars for £500, while the entire outfit for a three-furrow plough costs £400, and for a two-furrow plough £300. In addition to this, the dynamos will cost about £220, £200, and £100 respectively. According to the figures published as to the results of the trial, the working expenses of an electric plough are about half that of steam ploughing, and if these results are borne out in practice upon an extensive scale, there seems to be no question of the future of the electric plough.

Magnetic Strains. — Prof. C. G. Knott, D.Sc., F.R.S.E., and Mr. A. Shand have presented before the Royal Society of Edinburgh a further note on the volume changes which accompany magnetisation in iron and nickel tubes. In their previous communication in July last they gave the broad results for three nickel tubes of various bores. In these experiments the screw stopper through which the capillary glass tube passed was made of brass. This brass stopper was used because of the comparative difficulty of working nickel. The authors were led in the course of some tentative experiments to use this brass stopper with one of the steel tubes. In the earlier experiments with the iron and steel tubes they had used an iron stopper. They were hardly prepared, however, to find that the mere substitution of a brass for an iron stopper should

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produce such a marked effect, not only on the amount of change of volume in given magnetic fields, but also on the manner in which the volume change varied as the field increased or decreased steadily. This result at once proved that it was absolutely necessary to furnish the nickel tubes with a nickel stopper, and in the present note the authors give a comparison of the volume changes in steel tube V with (1) an iron stopper; (2) a brass stopper, and of the volume changes in nickel tube, I with (1) a nickel stopper; (2) a brass stopper. The numbers in the first column give the magnetic fields, the others represent dilatations or changes per unit volume, the unit being 10^{-7} cubic centimetre.

Field.	Steel tube, V.		Nickel tube, I.	
	Iron cap.	Brass cap.	Nickel cap.	Brass cap.
560	−58·7	− 0·6	−110	−107
500	−42	− 9·6	−109	−106
400	−30	−18	−107	− 98
300	−18	−12	− 96	− 89
200	0	− 7·2	− 72	− 67
100	+ 7·2	− 2·4	− 29	− 23
50	+ 3·0	− 1·2	− 4·5	− 4·5

In the case of the nickel tube the difference in the two columns is not of any great moment. With the nickel cap or stopper the changes of volume are slightly greater. This is very much what one would expect to find; for the nickel stopper has the effect of lengthening by an inch or so the magnetisable bar, and the tube portion of the bar so lengthened will be more effectively magnetised than when the stopper is of a non-magnetic metal. But it will be noticed that the behaviour of the steel tube is greatly altered when the brass cap is substituted for the iron cap. Thus there is no change of sign in field 200 when the brass cap is used, and there is no maximum negative dilatation in field 400 when the iron cap is used. In short, the character of the stopper has a marked effect upon the whole character of the strain. It is easy to see that the iron stopper will tend to increase the induction into the tube, but except in the way of diminishing the induction, and so altering the accompanying change of length, the authors cannot credit the brass stopper with any effect upon the longitudinal strain. It is as a disturbing factor in the transverse strain that it has to be considered. It does seem extraordinary, however, that a stopper whose hampering action is confined to one end of a fairly long tube should, by its inability to yield to the magnetising forces acting on it, produce such a marked effect upon the volume changes taking place in the tube as a whole. A closer investigation of the phenomenon may throw some light on the character of the strains accompanying magnetisation.

Electric Lighting of the North Sea-Baltic Canal.—The electric lighting arrangements in connection with the North Sea-Baltic Canal have been carried out by the Helios Company, of Cologne, who have for the past 10 years exploited in Germany the alternating-current transformer system. The following principles were laid down for the scheme, which comprised not only the lighting of the canal but of the locks, harbours, buildings, and harbour lighthouses: (1) two central stations were to be established, one at Holtenau and one at Brunsbüttel; (2) the stations were to be supplied with the safest and economical machinery and apparatus, with an ample reserve; (3) the tension of the current in both stations was to be kept constant whatever the change in the load might be; (4) each lamp was to be independent from the others, so that in the event of a large number of lamps being extinguished there should be no effect on those which remained lighted. At both ends of the canal, central machinery-houses have been established for the hydraulic plant operating the locks, and also for the electric lighting plant. Each installation has two low-speed steam dynamos of 200 h.p., running at 85 revolutions per minute. The engines are horizontal tandem engines with governors, by the Augsburg Machinery Works. An alternating-current dynamo is coupled direct to each engine, the magnetic field being combined with the flywheel. With their normal load, the output of the steam dynamos is 100 kilowatts. At Brunsbüttel there is a small additional steam dynamo of 12 h.p. for lighting the lock chambers during the daytime. For the lighting of the boiler and machinery houses, the buildings, the locks, and the harbour lights, the high-tension current of 2,000 volts is transformed to the required pressure by Helios transformers. There is a large number of arc and incandescent lamps both at Holtenau and Brunsbüttel. The standards at the locks have each four lamps of 25 c.p. The conductors are mainly carried underground, and consist of concentric armoured cables. For lighting the canal, which is 98 kilometres, or, say, 60 miles, in length, there are four divisions, one for half the length on either side. Each division has 250 incandescent lamps of 25 c.p., so that the distance between each lamp averages between 600ft. and 700ft. There are lakes, however, on the course of the canal, and these being lighted by gas buoys, and not electrically, the electric lamps are really closer than shown by the average calculation, the distance between them varying from 260ft. to 800ft. Overhead copper 4mm. conductors are used for the lighting of the canal. The installation has proved to be very efficient, and to fulfil the conditions laid down. We shall give further particulars, with illustrations, of this undertaking at an early date.

Technical Education in London.—The annual report of the Technical Education Board of the London County Council records the progress made in "co-ordinating and supplementing the provision for all the varied branches of technical education in London" during the past year. In the intermediate or secondary schools, in the evening classes, in every branch of science and technology, in all the departments of art training, and in the various subjects included under the head of domestic economy a great deal of work has been done. The main object has been to afford additional inducements and facilities for the poorest parents to keep their children at some secondary or continuation school after leaving the elementary school. The award of the intermediate and of the senior county scholarships establishes the link between the public elementary school and the university or technical college of university rank, while the scholarships and exhibitions in domestic economy, in art, in science, and in technology, the report states, are giving additional stimulus to the study of these subjects, and offering facilities to many who are engaged in trades or handicrafts to pursue special studies that will help them in their callings. The junior county scholarships which are open to boys and girls under 13 years of age offer free education for two years, together with money payments amounting to £20 in the two years, and have been eagerly sought after. In November, 1893, there were under a thousand competitors; at the examinations held last month the entries numbered 2,084. The success which has attended these scholarships has induced the Board to award 600 instead of 500 as originally proposed. The intermediate scholarships give education up to the age of 19, together with money payments rising from £20 to £35 a year. At the first examination, held last year, 348 candidates presented themselves, 148 being girls; and the competition proved so good that the Board decided to award 50 scholarships instead of 30, as originally proposed. Of these, 35 were

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awarded to boys and 15 to girls. Very favourable reports have been received of the progress of the intermediate scholars; two have passed the London matriculation in the first division, and several others have distinguished themselves in public examinations. Next come the senior county scholarships, which are intended to afford to the most promising and deserving students an opportunity of receiving that advanced instruction at universities, or institutions of university rank, which they would otherwise be unable to obtain, and they give free education together with a money payment of £60 a year. There are now over 600 county of London scholars attending intermediate or secondary schools. A sum of nearly £15,000 has been devoted during the year towards aiding these schools, and a grant of £1,000 has been made to University College and £500 to Bedford College. Turning to polytechnic and evening instruction, the Board expresses satisfaction at the high standard of quality and thoroughness to which the instruction given in these institutions has been raised. The total annual expenditure of the eight institutions open last year amounted to £90,000, their total number of students to 27,000, and their aggregate number of separate classes or courses of lectures to over 1,250. The aid given to the polytechnics takes the form of grants made on conditions calculated to promote efficiency. The Board's financial position is as follows: The appropriated balance on April 1, 1894, was, in round numbers, £31,000. The County Council made a further grant for 1894-95 of £57,000. During the year there was appropriated £64,000, leaving a balance unallotted of about £24,000, which is carried forward to next year.

Electricity in Medicine.—We have received from Dr. William James Morton, professor of electro-therapeutics at the New York Post-Graduates' Medical School and Hospital, a pamphlet on "Electricity in Medicine: from a Modern Standpoint," being a contribution to a discussion before the Medical Society of the State of New York. He says that there are times in the history of the world—in the history of medicine—when certain subjects are rife. Such a period is now with us as regards electricity, and physicians cannot, even if they strive to do so, keep out its influence. Electricity has revolutionised chemistry long since—the fundamental laws of chemistry and electricity are but two aspects of one and the same thing; it has revolutionised physics, for light, or the science of optics, and the science of electricity are now regarded as one and the same science; it is now revolutionisng the industries and the habits of mankind. Electricity will not revolutionise medicine, and not even the therapeutics of medicine; for medicine is a complex science, built upon many foundations where electricity is not directly involved, and therapeutics seeks aid from every quarter, and electricity is but one of these aids. But in this, the electric age, the physician alone of educated men cannot remain isolated from the general advance, cannot lag behind in this great branch of scientific thought and practice; for it is he who, in the race for the good and the happiness of the human kind, has ever kept in the vanguard of information in the physical sciences even at great sacrifices to his personal comfort and without remuneration. Electro-therapeutics must partly be narrowed down to specialists. Its advanced and best work must certainly be in such hands, but there still remain a large number of specific procedures of great importance in medicine and surgery which may be perfectly grasped and aptly applied by the general practitioner. And the number of such procedures will more and more increase as the medical schools of the land adopt or perfect teaching of elementary electro-physics in their curriculum, and as the newly-trained men spread outward to their work. If the physician does not take up this question he will be hopelessly behindhand in a branch of science which now closely interests the entire civilised world, and there can be no doubt that in not taking it up he may be charged with neglecting the interests of his patients. Furthermore, he cannot decide upon the merits of the uses of electricity in medicine if he is in entire ignorance of the subject. The true position to-day is that of conservatism—a conservatism based upon knowledge of the subject, and not that pseudo-conservatism based upon scepticism; for a blind and unreasoning scepticism has no place in science any more than an equally blind faith. There can be no doubt that in selected cases, and with skilled use, electricity can render to medical practice important aid, now unavailable by reason of the inadequate attention paid to the subject. And after dealing with electro-physiology and electro-therapeutics Dr. Morton comes to the following conclusions: (1) that a definition of electro-therapeutics in a biological sense is that it is the transformation (by the law of conservation of energies) of electric energy into the energy peculiar to vital cells; (2) electricity in medicine must be regarded not as an entity, like a drug, but as having a variety of "properties," such as electrolysis, cataphoresis, contraction of protoplasm, etc., each of which properties may be employed singly or combined to combat given morbid conditions or diseases; (3) of the galvanic current it may be concluded: (*a*) that strong currents depress nutrition of tissues, and produce structural changes leading to physiological atrophy (twenty to a hundred milliamperes); (*b*) that mild currents stimulate nutrition and produce physiological hypertrophy (one to eight milliamperes); (*c*) that mild galvanic currents, pulsating or alternating, produce similar effects to mild continuous currents; (*d*) that the negative pole is specifically indicated in that large class of cases termed chronic inflammation where newly-formed fibrous tissue or exudate occurs; (*e*) that upon the writer's theory—already accepted by several prominent physiologists—and observations, that catabolic or destructive events in tissue uniformly present the sign of negativity—that is to say, are at their origin electro-positive (resembling the zinc of a voltaic cell), the negative pole is indicated to arrest the catabolism, the positive to augment it; (*f*) that the positive pole is rarely indicated, and, if so at all, upon the basis of an electro-tonic effect to produce sedation of neuralgic pain in superficial nerves. (4) Of the Faradaic current it may be concluded—(*a*) that its main uses are to tetanise muscle and to cause sedation of pain; (*b*) that the tetanising current as now employed to treat paralysed muscles is injurious, since it enfeebles the muscle and causes atrophic structural changes; (*c*) that to strengthen or properly exercise a paralysed muscle, a slow rhythm of the Faradaic current—about 30 waves to the second—should be adopted; (*d*) that in some spastic conditions of muscles—due to paralysis of an opposing group—the strong tetanising current may be used to advantage to overstimulate and thus to fatigue the muscle; (5) of the Franklinic current, or statical electricity, it may be concluded that it is an adjunct of great efficiency in practice, since (*a*) it evokes the usual nerve and muscle reactions; (*b*) it affords a most convenient means of stimulating the peripheral distribution of the nerves in the skin, producing counter irritating, reflex, and other afferent impression effects; (*c*) it has a local perturbatory action (spark); (*d*) it produces profound alterations in the metabolism of the individual, increasing the natural waste products, and diminishing the toxic or by-products. For this reason, it is specifically indicated in cases of malnutrition, whether local or general.

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ELECTRIC LIGHTING OF TRAINS.—IV.

BY R. W. WEEKES, WHIT.SCH., A.M.I.C.E.

(Continued from page 622.)

GREAT NORTHERN RAILWAY COMPANY.

In July, 1886, the Great Northern Railway Company applied the electric light to one of their metropolitan trains, and subsequently to other uncoupled trains. A dynamo, together with certain accumulator cells, was placed in the guard's van, and driven by belting, or more direct means, from the axle of the vehicle. Automatic apparatus was provided, by which the direction of the current in relation to the accumulators was controlled, and the dynamo connected to the batteries when it had attained the necessary speed, and had consequently the requisite E.M.F. The dynamo, the cells, and the lamps were all arranged in parallel circuit—two main cables being led from the cells throughout the train. The system of lighting was practically that usually adopted in stationary or domestic installations, with the addition of the necessary automatic apparatus for controlling the current evolved by the dynamo under the varying speed and direction of the train.

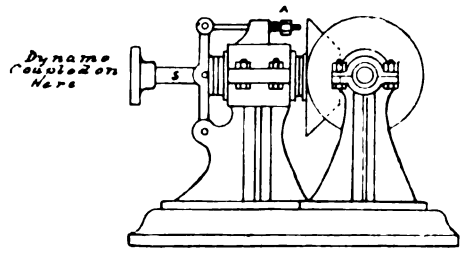

FIG 20

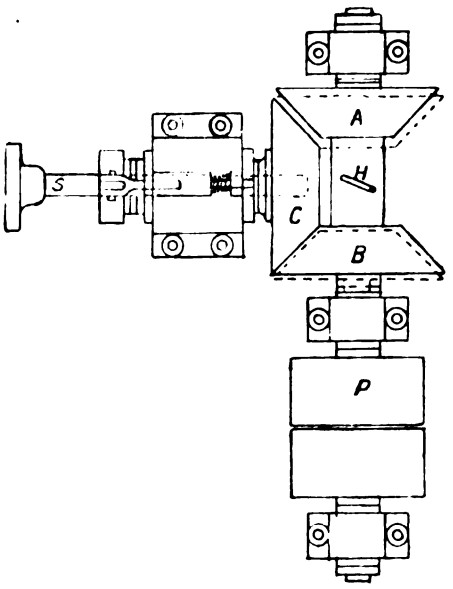

FIG. 21.—Friction Cone Gear for Automatically giving Uniform Direction of Rotation to the Armature.

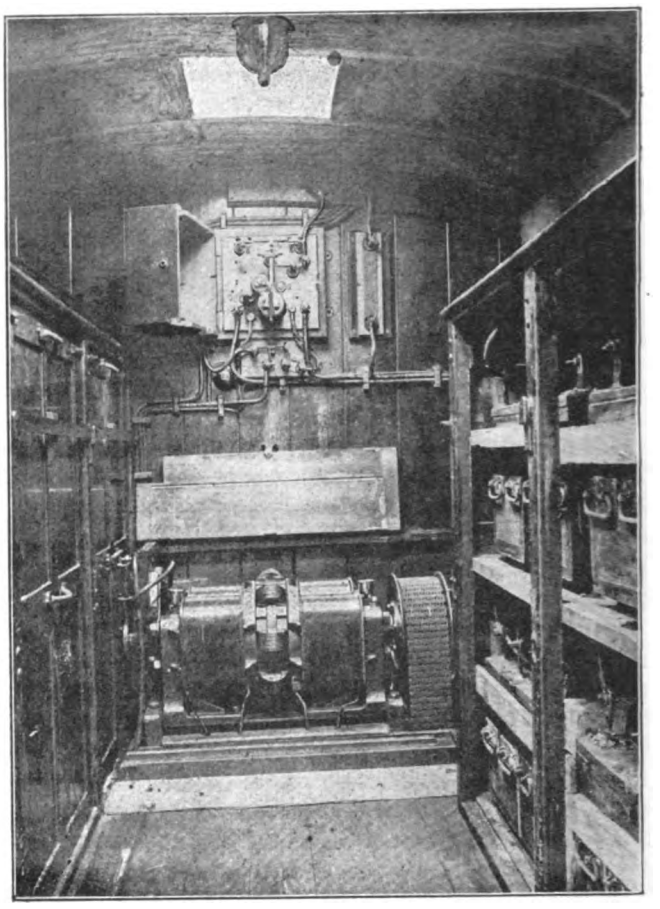

FIG. 22.—Train-Lighting Compartment on the Great Northern Railway.

Commencing to light the trains electrically at this early date, the company had to depend on the inventive genius of its own officials to a very large extent. Mr. T. Ireland and Mr. F. W. Cook took the matter up vigorously, and have made several successful departures from recognised practice. As in almost all engineering work, the success of the lighting gears is ruled by the details of construction, and it is to details that so much attention has been given by the officials of the Great Northern Railway Company. At first, an attempt was made to ensure uniform direction of rotation of the armature independent of the direction in which the train was travelling.

The construction of the mechanical gear by which this result was obtained, and which was used for several years, is shown in Figs. 20 and 21. The belt from the axles of the guard's van drove the pulley, P, the direction of rotation varying with the direction in which the train was travelling. This pulley was keyed on to the shaft running through the sleeve, on which were keyed two friction cones, A and B. This sleeve was free to move through a small arc, while the pin, H, traversed the spiral slot, H. The dynamo shaft was coupled rigidly to the shaft, S. The friction cone C was free to slide to and fro on this shaft, but was prevented from turning by means of a sunk key. The method of working was as follows: If the belt on the top of the pulley, P, is moving from left to right, the pin will move with the position shown in Fig. 20. The spirality of the groove, H, will bring the friction cone B into gear with C. This cone C was held up to its work by a spiral spring, X (Fig. 21). Now, if the train stopped, and began to travel in the opposite direction, the pin moving back through slot H will bring the cone A into gear with C. This will counteract the different sense of rotation of the shaft driven by the pulley, P, and keep the direction of rotation of the dynamo constantly the same. Mr. Cook assures me that this apparatus was fairly successful, but it was naturally found that it was easier to reverse the electrical connections and to alter the lead of the brushes than to mechanically reverse the direction of motion. The dynamos used in these first trains were of the Brush open-coil type, as described in a previous article.

The present arrangement of machinery for electrically lighting the trains of the Great Northern system is shown in Fig. 22, and again in elevation in Fig. 23. All the machinery is placed in a small compartment adjoining the guard's van. The dynamo is at the further end, as shown, the brush rocking gear being behind the set of accumulators on the right. On the left-hand side, the accumulators run the full length of the compartment. As will be seen from Fig. 23, there is a countershaft directly under the dynamo, and the belt-tightening gear is so arranged that one movement tightens both belts simultaneously. In this case, one belt only is used both from the countershaft to the dynamo and from the axle to the countershaft. The rest of the apparatus is shown either diagrammatically in Fig. 23, or in perspective in Fig. 22. The use of the various parts can best be seen by the diagram of connection, Fig. 24. The current from the brushes goes to the pole reverser, P, which is placed at the left-hand side of

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the dynamo. This reversing switch is worked by two friction surfaces working against a plate on the shaft, which can be seen in Fig. 22.

The details of the switch showing the trailing friction surfaces and the brush connections are shown in Fig. 28.

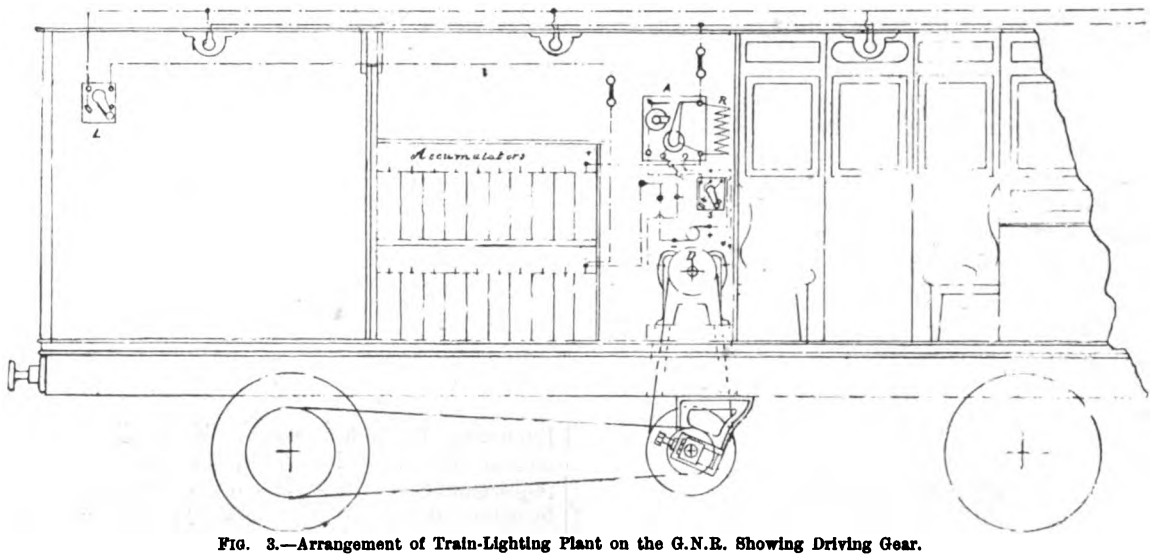

FIG. 3.—Arrangement of Train-Lighting Plant on the G.N.R. Showing Driving Gear.

From this reversing switch the current passes to a hand switch, G S, which cuts off the dynamo in case of emergency. From this it goes to the automatic switch, which is placed above the dynamo. The connections of this switch are shown in Fig. 25. The shunt coil in this apparatus connects the dynamo to the battery when the voltage rises to that required to charge the accumulators.

The automatic variation of the lead is effected by an exceedingly neat combination of governor balls and drag links. The method is shown in Fig. 27. In the driving pulley there are two weights working on guides. Springs hold these down in the position shown when the machine is at rest, but on the speed rising they fly out and actuate the levers, G G. From the other ends of these levers two drag links

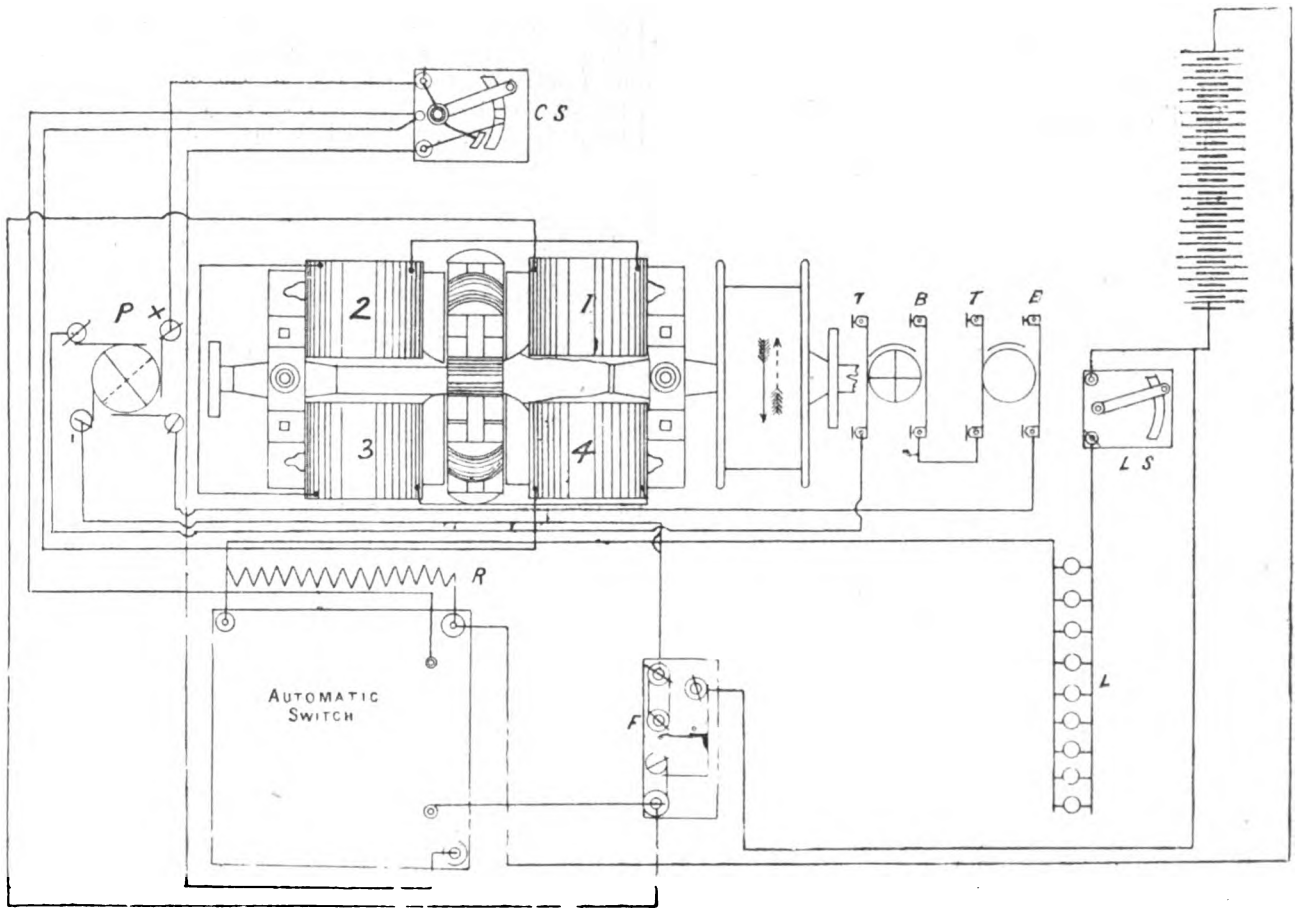

FIG. 24.—Diagram of Connections.

At the same time, resistance is automatically put into the lamp circuit to prevent the lamp being over-run due to the charging pressure being above that of the discharge.

A fuse board, F, and a lighting switch, L S, are also provided. The brushes and brush gear form one of the essential features of this system. The brushes consist of thin sheet-copper springs, Fig. 26, placed end on on the commutator. Some four or five of these springs are placed side by side, so that on the average at least four are making good contact with the commutator segments. One steel spring forces these copper springs down as they wear away, and the holders, of which there are two to each commutator, are also supported by steel springs.

connect on to the commutator bush, and move it round the shaft to a position varying with the speed. The direction in which the motion takes place is determined by the direction of rotation, as the force required to drive the commutator, which is otherwise loose on the shaft, is sufficient to give the just slight obliquity in one direction or the other.

The commutators, brushes, and all the small parts

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connected with this gear are made at the company's own workshops, at Finsbury Park, under the superintendence

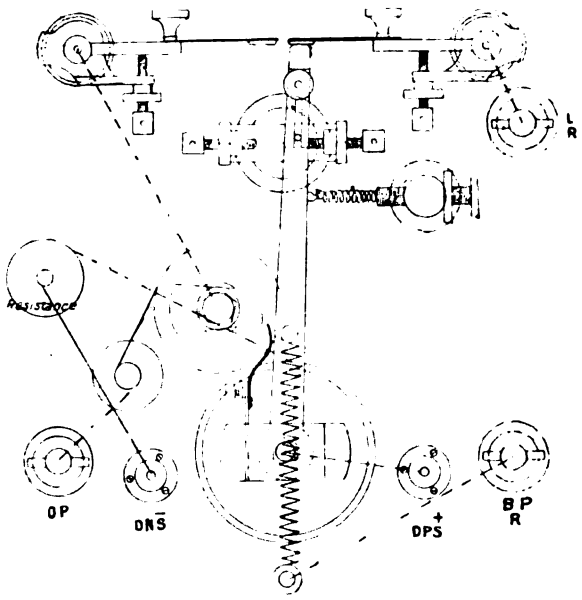

FIG. 25.—Connections of Switch for putting the Dynamo into Circuit, etc.

of Mr. C. J. Cooke, who has charge of the whole of the electric lighting on the trains.

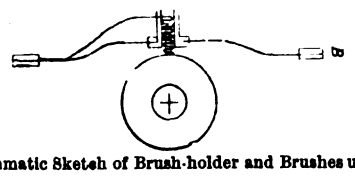

FIG. 26.—Diagrammatic Sketch of Brush-holder and Brushes used on the G.N.R.

The accumulators, of which there are 22 in each coach, are of the E.P.S. manufacture, and are placed in stands at either side of the compartment, as shown in Fig. 22.

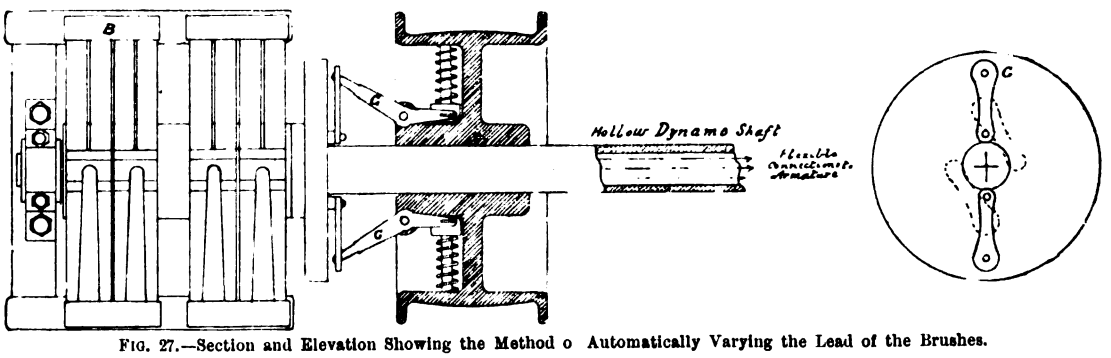

FIG. 27.—Section and Elevation Showing the Method o Automatically Varying the Lead of the Brushes.

Strong wood panelling prevents accidental damage being done to them by the attendant while seeing to the dynamo, and they are carefully wedged in their places.

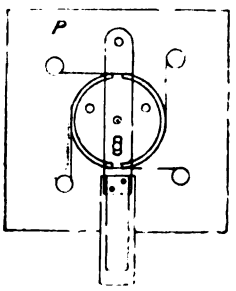

FIG. 28.—Reversing Switch and Gear.

The train consists of 11 coaches, and the candle-power provided is as follows:

8 first-class compartments with one	16-c.p.	lamp	in	each	= 128 c.p.
20 second-class ,, ,, ,,	12	,,	,,		= 240 ,,
20 third-class ,, ,, ,,	8	,,	,,		= 160 ,,
3 brake-van and dynamo ,, ,,	8	,,	,,		= 24 ,,
					552 ,,

Eight trains are now fitted and in regular work, and the cost per train per annum for upkeep is about £150. The rest of the figures for cost, etc., kindly furnished by the engineers of the company, are as follows: initial cost of outfit, £36. 7s. 2d. per carriage; average candle-power per carriage, 50; cost of supplying the light per candle-power hour, ·0258d. The regulation of the E.M.F. will naturally have the same faults as were described on the Brighton system, as the same type of dynamo is used. Still, although with wide ranges of speed the variation of voltage exceeds somewhat the Board of Trade standard, the light is practically successful, and on ordinary trains is really first-class.

THE ELECTRICAL LABORATORY OF THE CITY OF LONDON COMMISSION OF SEWERS.

In order to be able to commence work at once, Mr. A. A. Voysey, the electrical inspector of the above Commission, has fitted up a temporary laboratory in the Wool Exchange, Basinghall-street. New offices and extensive laboratories are being built, but in the meantime the requirements of the public using the electric supply can be attended to from the laboratory, which we inspected last week.

A well-lighted room, 29ft. by 23ft., has been rented for the purpose, and Mr. Voysey has been busily employed in designing and arranging the present testing appliances. There is no doubt that the experience gained with these temporary arrangements will serve as an excellent guide when the new premises are ready to be equipped.

The testing of electricity meters is expected to be the most extensive work of the laboratory, and the following arrangements have been made for this purpose. Alternating current at 100 periods is supplied at 200 volts from the two outside wires of the City of London Electric Lighting Company's three-wire system. The primary of a special 10-unit transformer, manufactured by Messrs. Ferranti, Limited, is connected to these mains. There are three secondary windings on it—one wound to give 100 volts and two amperes, another to give from 90 to 110 volts, varying by two-volt steps, and two amperes; the third winding will give any voltage from 2 to 20 volts, varying by two-volt steps, and 500 amperes. The 100 and 110 volt coils are intended to supply the shunt coils of meters, and are joined in series. A 13-way commutator is provided by which the pressure of the supply to what we may call the shunt circuits of the meters can be varied from 90 volts to 110 volts, by steps of two volts, or from 190 volts to 210 volts by similar steps. The third secondary supplies current at low pressure to a separate circuit to which are connected the electrical quantity meters or the series coils of electrical energy meters. A commutator which will carry the full current of 500 amperes, and by which the pressure may be varied as required from 2 to 20 volts, is connected up to the thick-wire coils of the transformer. The current passes from the commutator through fuses and a double-pole switch to a copper strip extending round two sides of the room (Fig. 1). A polished teak board, 4½in. by 1½in., supported by iron bolts fixed in the wall, carries the 1½in. by ⅛in. copper strip, the lead being screwed on the back of the teak and the return bar on the front. The copper strip is enamelled bright blue and shows up well on the polished

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teak. Slate shelves on solid wood corbels are arranged on one side of the room, 2ft. 6in. below the copper strip and 3ft. from the floor. These carry the standard measuring instruments, which consist of four Kelvin instruments—*i.e.*, deci, deka, and hekto ampere balances, and a watt balance reading up to 20 kilowatts. Two Kelvin multicellular electrostatic voltmeters are placed on the buttress, as shown in Fig. 1, for the purpose of measuring pressure. Above each balance the copper strip is cut and the instrument connected across the break, those not in use being short-circuited by means of a copper bar with winged nut terminals. Similar breaks are provided for the insertion in the circuit of meters and a non-inductive resistance for regulating the current. The pressure leads are placed on the top of the teak board, and are accessible at any part.

The non-inductive resistance for regulating the current in the series coil is arranged on an ingenious system by Messrs. Ferranti and Co., Limited. It is a particularly neat and compact apparatus, similar in principle to that made by the same firm for the purpose of meter testing at Portsmouth. Five vertical copper rods connected together at the top by a copper bar are surrounded concentrically by German-silver wires of slightly different lengths, which are also connected together at the top, but insulated from the copper bars. Below each set of wires is a mercury-cup, which can be raised or lowered by a hand-wheel actuating a screw. As the cup is screwed up, the ends of the different German-silver wires dip successively into the mercury. In this way they are put in parallel and connected in series with the copper bar which carries the current down into the mercury-cup. The first set of resistances consists of 10 wires, each carrying one-tenth of an ampere, or a total of one ampere when all are in circuit; the second consists of nine wires, each carrying one ampere, or a total of nine amperes; the third of seven wires, each carrying 10 amperes, or a total of 70 amperes; the fourth of seven wires, each carrying 20 amperes, or a total of 140 amperes; and the fifth of seven wires, each carrying 50 amperes, or a total of 350 amperes. Therefore, when the five cups are all in their highest position, the resistance will carry 500 amperes. It would be quite easy, if required, to provide the observer at any of the balances with a means of regulating the resistance, by cords passing from the hand-wheels on the mercury-cups round the room. The great advantage, besides the cost of adjustment, is that the wires being straight, and everywhere exposed, the final temperature is reached very quickly. For the purposes of measuring conductor and insulation resistances, comparing capacities and potential differences, a Kelvin reflecting galvanometer and testing table is provided. The galvanometer has separate high and low resistance coils, and is placed with a Jacob transparent scale on brackets let into a solid-brick pillar. Opposite it is the testing table, with a sloping top of polished teak, on which are fixed a four-dial Wheatstone bridge, a standard $\frac{1}{4}$ meghom, a ·3 microfarad standard condenser, and two Carhart-Clark standard cells, with galvanometer shunts, short-circuits, battery commutator and reversing key, and circuit commutators. The connections are so arranged that the alteration in the position of two plugs effects the change from the Wheatstone bridge connections to the connections for the direct deflection test for insulation or capacity. On a shelf below are two trays containing 100 dry cells and four Leclanché cells. The table and instruments have been supplied by Messrs. Nalder Bros. A standard barometer and thermometer are also provided.

The general view of the laboratory is shown in Fig. 1, and from it the arrangement of the various apparatus can be understood. The only point on which we do not agree with Mr. Voysey is in the arrangement of his current circuits. The low-voltage method is excellent, but the main copper bar and resistance adjustments do not readily admit of more than one class of instrument being tried at one time. In the same way, all the three Kelvin balances are in series on the strip, and cannot conveniently be used for different currents at the same time. We understand that Mr. Voysey means to use commercial ammeters in parallel circuits, and to regularly calibrate these instruments against the Kelvin balance.

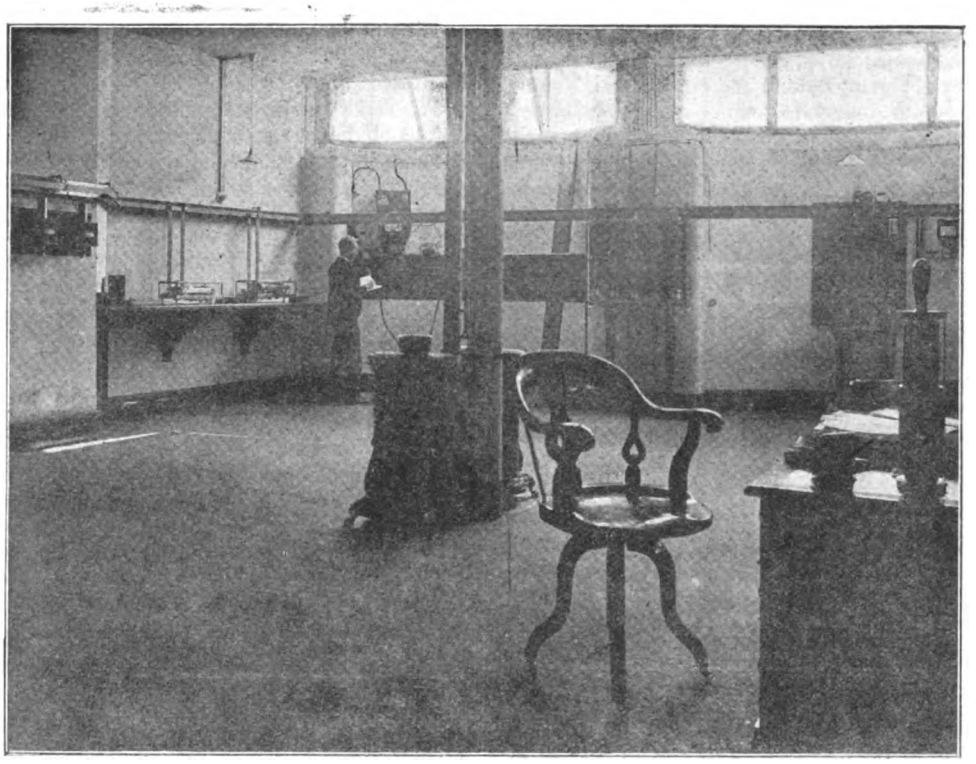

FIG. 1.—Electrical Laboratory of the Inspector for the Commission of Sewers

As the duties of the electrical inspector of the Commission of Sewers are not generally known in full, we give herewith the details of his duties as approved by the Commission recently. We were allowed by Mr. Voysey to see the record book of the faults in the City arc lighting. As is well known, the police report regularly all such faults they observe, and the City of London Electric Lighting Company's officials have to report on the cause of the failures observed. Since October last, on a large number of circuits, the faults in arc lamps reported range from four to seven, a fact which redounds to the credit of the lamp trimmers and all connected with the public lighting of the City of London. We wish Mr. Voysey every success in his new laboratory, and congratulate him on the outfit of it.

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Duties of Electrical Inspector and Scale of Fees under the Electric Lighting Provisional Orders, approved by the Commissioners of Sewers, March 5, 1895.

Meters.—He shall test meters when required to do so by the undertakers, or any consumer, on the payment of the proper fee, and shall certify meters in accordance with the conditions of the provisional orders.

Undertakers' Lines and Works.—He shall follow and check, as far as possible, the testing done by the undertakers, and shall make additional tests whenever such appear to be necessary. The tests shall be made in accordance with the conditions of the provisional orders.

Undertakers' Instruments.—He shall report from time to time as to the necessity of testing and taking readings of the undertakers' instruments, and shall take such readings or tests when required to do so.

Testing on Consumers' Premises.—He shall test the electric pressure at consumers' terminals, and the undertakers' lines or works on the consumers' premises, if required by a consumer. He shall also, on any consumer's order, test his wires and fittings, where dispute has arisen between undertakers and consumer as to the condition of such wires and fittings.

Report of Testing.—If any test is made on the requisition of a consumer, the undertakers, or the Commission, a report of the result shall be made to him or them, as the case may be, on the following day. All tests shall be recorded and reported to the Commission.

Electrical Inspector's Duties Relating to Public Lighting.

Lamp Failures.—He shall supplement the work of the police, as far as possible, by reporting defects and failures in the public electric lighting.

Energy Supplied to Lamps.—He shall test the energy supplied to the public electric lamps from time to time, to see if it is up o contract value.

Lighting Failures.—He shall investigate and report on failures in the public electric lighting when they occur.

Cost of Altering Lamps.—He shall watch alterations to existing public electric lamps, and check and certify the accounts for such works.

Electrical Inspector's Duties Relating to Public Safety.

Board of Trade Regulations for Safety.—He shall ascertain, as far as he can, whether the Board of Trade regulations concerning public safety are adhered to by the undertakers, and shall report any cases in which he may find that they are not. He shall also report anything in the operations or system of the undertakers which he may consider a possible source of danger.

Electrical Inspector's Duties.—Sundry.

Progress Reports.—He shall make weekly reports of the street works executed by the undertakers, and shall inspect such works in progress as often as possible.

Public Convenience During Street Works.—With a view to the electrical engineering necessities of the street works, he shall consider the possibility of reducing public inconvenience caused by the works, and make what suggestions he can.

Board of Trade Regulations as to Supply.—He shall ascertain, as far as he can, whether the Board of Trade regulations as to supply are adhered to by the undertakers, and shall report any cases in which he may find that they are not.

Failures in the Private Supply.—He shall investigate and report on failures in the private supply.

General.—He shall perform such other duties as may appear to obviously belong to the work of an electrical inspector; and, as experience directs, may report from time to time on the necessity for adding to or modifying the above list of duties.

SCALE OF FEES FOR TESTING.

Examining Meters for Certification.	£	s.	d.
Single meters, any type, up to six kilowatts	0	10	0
Above six kilowatts, but not over 12 kilowatts	0	15	0
Above 12 kilowatts, but not over 30 kilowatts	1	0	0
Above 30 kilowatts	1	10	0
For batches of not less than six meters of the same capacity and type, up to six kilowatts, per meter	0	5	0
Above six kilowatts, but not over 12 kilowatts, per meter	0	7	6
Above 12 kilowatts, but not over 30 kilowatts, per meter	0	10	0
Above 30 kilowatts, per meter	0	15	0
Tests of Undertakers' Instruments.			
Voltmeters.			
Single, any type, reading up to 300 volts	0	5	0
In batches of not less than six, any type, per instrument	0	2	6
High-pressure voltmeters, each	0	10	0
High-pressure voltmeters, in batches of not less than six, per instrument	0	5	0
Ammeters.			
Single, any type, up to 50 amperes	0	5	0
Above 50, but under 100 amperes	0	7	6
Above 100, but under 250 amperes	0	10	6
Above 250, but under 500 amperes	0	15	0
Above 500	1	0	0

In batches of not less than six of same capacity, for each instrument one-half of the fee fixed for a single instrument of the same capacity.

Mains.			
Insulation, each test	0	10	0
Conductivity, each test	0	10	0
Service lines.			
Insulation, each test	0	5	0
Conductivity, each test	0	5	0
Efficiency of joints, each test	0	5	0
Undertakers' lines, other than main or service lines.			
Insulation, each test	0	5	0
Conductivity, each test	0	5	0
Variation of pressure at consumers' terminals	1	10	0
Test of apparatus and works of the undertakers upon a consumer's premises	0	10	0

INSTITUTION OF CIVIL ENGINEERS.

The annual general meeting was held in the hall of the Royal United Service Institution on Tuesday, the 28th ult., Sir Robert Rawlinson, K.C.B., president, in the chair.

The report of the council commenced by referring to the change that had taken place in the roll of the society during the past 12 months, during which 29 members, 286 associate members, and five associates had been elected, and two members and three associate members were restored to the roll; while the deaths, resignations, and erasures amounted to 170. The net increase was therefore 155, or at the rate of nearly 3 per cent. per annum. The numbers of all classes on the books at the end of the institution year were: honorary members, 17; members, 1,862; associate members, 3,687; associates, 355—making a total of 5,921. Attached to the institution, though not forming part of it, was the student class, the conditions of admission to which had continued to exercise the earnest attention of the council. For the first time since the introduction of the higher qualifications of candidates for admission as students, the council was able to report an effective increase in the roll, the number on March 31, 1895, being 816, or 25 more than at the same date last year.

The statement of accounts, as vouched for by the auditors, showed that the receipts of the year had been—on income account £20,970. 3s. 10d., on capital account £8,933. 1s. 2d., and on trust funds account £445. 13s. 2d.—together £30,348. 18s. 2d. The general expenditure amounted to £18,385. 10s. 11d., which included the cost of four volumes of *Minutes of Proceedings*, part payment for the subject index to vols. lxix.-cxviii., the revision and printing of the new library catalogue, and the succession duty on the Palmer bequest. Capital expenditure had absorbed £7,130. 8s. 11d., mainly on account of the new building, and trust funds expenditure £492. 9s. 6d.—together £26,008. 9s. 4d. The Palmer scholarship previously mentioned represented a bequest of £1,500 (less legacy duty and subject to a life interest) from the widow of a former vice-president of the institution, to be devoted to the foundation of a scholarship at Cambridge University, tenable by the son of a civil engineer in need of such assistance. This bequest, reverting to the institution by the death of the holder of the life interest, had been diminished by the legacy duty on the first succession to £1,381. 1s. 6d., which sum was invested in the Metropolitan Board of Works 3 per cent. stock. Under the new estates duty this sum became further liable to a charge of £173. 2s. 3d. In order, therefore, that the fund might not be depreciated to an extent incompatible with giving proper effect to the generous founder's object, the council decided that the institution should discharge the claim for succession duty. The proceeds of the Palmer scholarship might be estimated at £40 per annum.

Owing to the necessity of delivering, in April, the meeting-room to the contractors for the new building, the institution met for the reading and discussion of papers on

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only 20 evenings during the past session. Exclusive of the president's address, 14 original communications were read and discussed, but the exceptional interest evinced in the debates on some of the subjects brought forward, had resulted in a full amount of material being available for the customary four volumes of *Minutes of Proceedings*. A brief summary was given of the several papers brought under the notice of the members. Reference was also made to the large number of interesting communications selected for printing in Section II. of the publications. For some of these papers awards of medals, or premiums, or both, had been made to Messrs. A. J. Durnston, R.N., J. I. Thornycroft, S. W. Barnaby, W. Duff Bruce, S. J. Berg, C. Butters, E. Smart, J. Richardson, A. Sharp, J. A. Griffiths, A. J. Hill, O. Guttmann, K. Leibbrand, A. Scott, D. Cunningham, and to the representatives of the late H. Gill.

As in the preceding session, 11 supplemental meetings for students had been held, at which papers were read and discussed—some exhibiting sufficient merit to warrant their publication in the *Minutes of Proceedings*. The reports received from Manchester, Glasgow, Birmingham, Newcastle-on-Tyne, and Leeds showed that the associations of students at those centres were continuing to fulfil well the objects for which they were established. The council had awarded Miller prizes to the following students for papers read at the institution and before the local associations: Messrs. W. G. Wales, S. H. Barraclough, E. E. Matheson, A. M. Stewart, R. C. Farrell, and H. Fowler.

The third of the series of "James Forrest" lectures had been delivered, on May 2, by Prof. W. C. Unwin, F.R.S., M.I.C.E., before a full and appreciative meeting.

The completion was announced of the new library catalogue, comprised in three volumes, copies of which would be issued to public libraries and those of educational and scientific bodies in all parts of the world. The new subject index to vols. lix.-cxviii. was in print, and would be issued during the recess.

The council had given considerable attention to the question of enabling all entitled to vote at the annual election to exercise that privilege whether present at the meeting or not. The opinion of counsel was, however, that under the existing charters such votes could only be given personally.

The report finally referred to the operations connected with the rebuilding of the premises, as to the completion of which it was premature at the moment to make a definite statement.

The report having, after full discussion, been adopted, votes of thanks were passed to the president, vice-presidents, and the other members of council for active services in the management of the institution; to the auditors for their care and trouble in examining the accounts, and to the scrutineers of the ballot.

The ballot for council resulted in the election of Sir B. Baker, K.C.M.G., as president; of J. Wolfe Barry, C.B., W. H. Preece, C.B., Sir Douglas Fox, and James Mansergh as vice-presidents; and of W. Anderson, D.C.L., Alex. R. Binnie, W. R. Galbraith, J. H. Greathead, J. C. Hawkshaw, C. Hawksley, Dr. John Hopkinson, Alex. B. W. Kennedy, LL.D., Sir G. L. Molesworth, K.C.I.E., Sir Andrew Noble, K.C.B., Sir E. J. Reed, K.C.B., M.P., W. Shelford, F. W. Webb, Sir W. H. White, K.C.B., and Sir E. Leader Williams.

The session was adjourned to the second Tuesday in November.

The following is a detailed list of the awards made for original communications submitted during the past session:

For Papers Read and Discussed at the Ordinary Meetings.

A George Stephenson Medal and a Telford Premium to Albert John Durston, engineer-in-chief R.N., for his paper on "The Machinery of Warships."

George Stephenson Medals and Telford Premiums to John Isaac Thornycroft,* F.R.S., and Sydney Walker Barnaby,* MM.I.C.E., for their joint paper "Torpedo-Boat Destroyers."

A Telford Medal and a Telford Premium to William Duff Bruce, M.I.C.E., for his paper on "The Kidderpur Docks, Calcutta."

A Telford Medal and a Telford Premium to Sigvard Johnson Berg, A.M.I.C.E., for his account of "The St. Gothard Mountain Railway and the Stanserhorn Cable Railway."

The Manby Premium to Charles Butters and Edgar Smart, A.M.I.C.E., for their joint paper on "Plant for the Extraction of Gold by the Cyanide Process."

A Crampton Prize to John Richardson, of Lincoln, M.I.C.E., for "The Mechanical and Electrical Regulation of Steam-engines."

For Papers Printed in the "Proceedings" without being Discussed.

A Telford Medal and a Telford Premium to Archibald Sharp, Wh.Sc., B.Sc., A.M.I.C.E., for his paper entitled "Circular Wheel Teeth."

A Telford Medal to the representatives of the late Henry Gill,† M.I.C.E., for his paper on "The Filtration of the Müggel Lake Water Supply, Berlin."

A Watt Medal and a Crampton Prize to John Alfred Griffiths, B.Sc., Wh.Sc., A.M.I.C.E., for his paper on "Windmills for Raising Water."

A Watt Medal and a Crampton Prize to Alfred John Hill, Wh.Sc., A.M.I.C.E., for his paper, "Repairs and Renewals of Railway Rolling-stock."

A Telford Premium to Oscar Guttmann, A.M.I.C.E., for his account of "The Removal of the 'Iron Gates' of the River Danube."

A Telford Premium to K. Leibbrand, of Stuttgart, for his paper "On a Concrete Bridge at Munderkingen."

A Telford Premium to Adam Scott, A.M.I.C.E., for his paper entitled "Deep-Water Quays at Newcastle-upon-Tyne."

A Telford Premium to David Cunningham, F.R.S.E., M.I.C.E., for his paper on "The Estuary of the Tay."

For Papers read at the Supplemental Meetings of Students.

A Miller Prize to William Garnys Wales, Stud.Inst.C.E., for his paper entitled "Caissons and Gates for Closing Lock and Dock Entrances."‡

A Miller Prize to Samuel Henry Barraclough, B.E., Stud. Inst.C.E., for the paper, contributed jointly with Lionel S. Marks, B.Sc., entitled "Some Experiments on the Heat Losses to the Cylinder Walls of a Steam-engine."‡

A Miller Prize to Edward Ewing Matheson, Stud.Inst.C.E., for his description of "Timbering in the Ampthill Second Tunnel."‡

For Papers read before Local Associations of Students.

A Miller Prize to Angus Matheson Steward, Stud.Inst.C.E. (of Glasgow), for his account of "The Glasgow District Subway."‡

A Miller Prize to Richard Craig Farrell, Stud.Inst.C.E. (of Glasgow), for his description of "The Permanent Way and Signalling of the Glasgow Central Railway."

A Miller Prize to Henry Fowler, Stud.Inst.C.E. (of Manchester), for his paper on "The Testing and Inspection of Plates.

EXHIBITION OF RAILWAY APPLIANCES AND INVENTIONS.

On Saturday afternoon last Lord Herschell opened at the Imperial Institute an exhibition of railway appliances and inventions. The exhibition, which will remain open till the end of August, is situated in a special building, but the space is somewhat cramped. The idea of the exhibition was first mooted on March 11, and approved of by the council two days afterwards. The new building had then to be erected, and the staff of the institute can be congratulated upon the fact that the exhibition was in perfect readiness on the opening day. There are in all 90 exhibitors.

Messrs. Siemens Bros. and Co., Limited, 12, Queen Anne's-gate, Westminster, show their hydrostatic contact apparatus for railway signalling. The object of the appa-

* Have previously received Watt Medals and Telford Premiums.
† Has previously received a Telford Premium.
‡ It has been determined to print an abstract of this paper in the *Minutes of Proceedings*.

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ratus is to produce automatically, by the passage of a train, electrical contacts at given points on a railway line, and to utilise such contacts for a variety of train-signalling purposes. The contact apparatus formerly adopted for such purposes usually consisted of one or more levers, which projected from a box fastened to the track, and reached somewhat over the rail. When a train passed this place, its wheels pressed down the levers and produced the desired contact in the box. The great difficulty experienced with such apparatus was the prevention of their destruction by the violent shocks to which they were subjected when a train met them. Somewhat successful improvements have been introduced in providing the contact levers with springs, but even these apparatus cannot be fully protected against external damage. The firm's contact apparatus, it is claimed, entirely overcomes the difficulty of preservation from damage by passing trains, and its extensive and increasing adoption has fully proved its practical value. The apparatus depends upon the bending of a rail, due to the passing of a train or an engine. It needs for its support no exterior points in connection with the ground, and can be made of any desired sensitiveness. The bending of the rail takes place between two fixed points resting on the sleepers. As soon as this portion of the rail is weighted by the wheel of a passing train a very slight movement is obtained by the bending of the rail, which is transferred to the electrical contact by hydrostatic pressure. Among other exhibits of the firm are a guard's van Morse inkwriter; a railway gong alarm, inkwriter, and inductor; telegraph poles showing screw-ring joints, buckle-plate, and pile tube; various insulators and brackets on pole and arms; linemen's tools; two pillars for arc lighting; Siemens's "Band" arc lamps, incandescent lamps, carbons, electric wires and cables; a telephone with siren call; and a set of Obach's dry cells, with a battery testing set of the same.

Messrs. Saxby and Farmer, Limited, Canterbury-road, Kilburn, have on view a full-size apparatus, being a union of the lock and block systems with wrought-iron signal and electric slot and replacer, and improved mercurial rail contacts. They have also an ingenious electric tablet arrangement for working single lines.

Mr. Wilfrid S. Boult, A.M.I.C.E., 60, Castle-street, Liverpool, exhibits a working model of apparatus for signalling passing trains without mechanical contact between the stationary and travelling parts. The method adopted is as follows: On the road are placed a series of permanent or electromagnets producing a magnetic field whose direction of flux is capable of reversal, but in either case transverse to the railway. The field may be continued along the line as far as necessary by employing a suitable number of magnets, all of which may be securely covered in. Carried by the train through the magnetic field is an iron armature, divided in the middle so as to admit of the insertion of a polarised contact-maker, which closes either of two local circuits according to the polarity of the field passed through.

A case of Aylmer-Leclanché, Leclanché-Barbier, and other cells, together with direct-current telephones and bells, and lightning protectors, is exhibited by Mr. R. Aylmer, 47, Victoria-street, S.W.

Messrs. Girdlestone, Tatham, and Co., 16, Davies-street, Berkeley-square, W., are lighting the hall with Andersen's 12-ampere arc lamps of 2,000 c.p. The lamps are fitted with "Holophane" globes, which are made of clear glass and cut in such a way as to distribute the light uniformly in the required direction. The lamps are simple in construction. They are made with large or small globes as required, and for running on continuous or alternating current circuits as required. Portable batteries and lamps, switches, bells and telephones, and fittings, are also to be seen here.

Messrs. McKenzie and Holland exhibit a working model showing three railway block stations, representing the combination of electric and block locking (Sykes's system). They have also an electric train treadle and an electric slot for signals.

Lacombe zinc cells, carbon-headed plates, carbon brushes, and Leclanché cells are included in the exhibits of Le Carbon, 7, Carteret-street, S.W.; and Messrs. Krupka and Jacoby, 15, Queen-street, Cheapside, are represented by Dr. Albert Lessing's dry batteries.

Mr. George Lopes, M.I.C.E., London Bridge Station (L. B. and S. C. Railway), exhibits an automatic electric railway alarm, the object of which is to warn people using level crossings of the approach of a train, and to warn workmen engaged in tunnels and other hazardous places.

Mr. W. Alfred Llewellin, 10, Park-row, Euston-road, Bristol, shows an apparatus by which a signalman, should he in error allow a train to proceed, can automatically place triple detonators in front of the train he has allowed to pass. The apparatus consists of a lead running along the line, this lead being connected with triple detonators throughout the line. Should the signalman accidentally allow a train to pass, he can subsequently cut the lead in his box and the detonators are thereby placed under the wheel of the train. At the same time, the release of the lead causes an electric incandescent lamp to be switched on as a danger signal on the line. Should, between any two sections, a train be derailed, the derailment causes the lead to be cut, placing detonators on the line to warn on-coming trains, at the same time switching on the electric danger lamp and ringing an electric bell in the signal-box. Should a train not derail, but get disabled through various causes, yet be in a perilous position which driver and officials think is or may be detrimental to an on-coming train, and consider that it is essential that the on-coming train upon off line is in some way endangered, the present system is to place fog signals on up and down lines by manual labour if time admits; but under the new system the cut line, as previously described, will perform all the requirements and inform all on-coming trains, all signalmen, block all lines, and give the indispensable light upon the scene.

THE MAGNETIC SURVEY OF THE UNITED KINGDOM.*

BY PROF. A. W. RUCKER, M.A., F.R.S.

The object of the magnetic survey is twofold: firstly, to determine the secular changes in the declination, horizontal force and dip; and, secondly, to investigate the local magnetic disturbances by which these elements may be affected.

In the years 1884-1888 the author and Dr. Thorpe, F.R.S., made magnetic observations at 205 places in the United Kingdom. The results were considered sufficiently interesting to make it desirable that the work should be extended. An allowance from the Government grant in aid of research enabled them to carry out this extension with the help of assistants—Messrs. Briscoe, Gray, and Watson. With the aid of these gentlemen the magnetic constants have now been determined at 882 places in Great Britain and Ireland. The two surveys have been worked up independently so as to give the magnetic condition of the United Kingdom on January 1, 1886, and January 1, 1895. The secular change between these epochs has been calculated, and all the observations have been finally reduced to the later date. By means of the table of secular change it will be possible to determine the normal undisturbed value of the declination at any place in the United Kingdom for some years to come, and by means of a map on which the deviation from the normal values is shown at 882 places it will be possible to gain some idea how far local disturbance is likely to affect the declination at any given place. Similar tables and maps are provided for the other magnetic elements.

As regards local disturbances, it is found that the north pole of the compass is attracted to certain regions and to lines which can be traced for scores or even for hundreds of miles. These lines are called magnetic ridge lines. As a general rule, a region where basaltic rocks appear in large quantities on the surface attracts the north pole of the magnet. On the basalt itself the disturbances are irregular, but an attraction towards it is observed at stations near to but not actually on the magnetic rock. This is very clearly shown in Antrim, in Scotland, between the Forth and the Clyde, and in North Wales.

The ridge lines to which the north pole of the needle is

* Paper read before the Federated Institution of Mining Engineers, May 31, 1895.

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attracted often run through districts in which the underlying strata are known to be non-magnetic for great depths. The author has, however, measured the magnetic permeability of a large number of specimens of basic rock, and has shown that magnetic disturbances of the magnitude of those observed in the United Kingdom can be accounted for if the surface strata conceal large masses of rock more magnetic than those which exist on the surface.*

For the purposes of the present communication it may be sufficient to select three points for special discussion.

I.—The Relations of the Lines of Disturbance to the Principal Coalfields of the United Kingdom.

These relations are not very simple, and can hardly be explained fully without the aid of the detailed maps now in the hands of the engraver.

Assuming that the positions of the magnetic ridge lines are determined by basaltic rocks, of which portions may or may not appear on the surface, it is probable that where numerous isolated patches of such rocks are visible, they are connected with a vast underground mass by which the needle might be affected at large distances. This is true of the Scotch coalfield. A ridge line runs from the neighbourhood of North Berwick to the Clyde between Glasgow and Hamilton, then turns south to Newmilns, and finally runs in a northerly direction towards Ardrossan and Cumbræ.

In the Northumbrian and the northern part of the Durham coalfield the magnetic disturbing forces are feeble, and are directed to the north and east. In the southern part of the Durham coalfield the influence of the great Yorkshire and Lincolnshire ridge line is felt, so that the disturbing forces are directed southwards.

The Yorkshire coalfield is dominated by a ridge line which runs south-west from Harrogate towards Keighley, and follows, or nearly follows, the outcrop of the millstone grit as far south as Matlock. The general tendency of the magnet in this region is therefore to deviate to the west.

In the southern part of the Derbyshire coalfield the north pole of the magnet is attracted from all sides to a centre which is a little to the north and east of Nottingham. The magnetic disturbances in the Lancashire coalfield are feeble, but on the whole the evidence bears out the conclusion that a ridge line runs from Rochdale to Wigan and Southport. This line, and that which roughly coincides with the Pennine range, are interesting examples of the fact that, when we are dealing with strata not later than the carboniferous rocks, lines of magnetic attraction are generally associated with lines of geological upheaval. If the cause of the magnetic attraction is the magnetisation of deep-seated magnetic rocks by the inductive influence of the earth's field, this would prove that the forms of the older surface rocks tend to follow the slopes of hidden magnetic masses. No such relation is observed in the case of strata deposited later than the carboniferous era. From the point of view of the magnetician the South Wales coalfield is divided into two parts by the River Taff, which runs into the sea at Cardiff. East of this boundary the magnet is strongly attracted to a centre which lies near Risca or the southern end of the Ebbw Vale. West of the Taff an important ridge line which runs across England, from Deal to Haverfordwest, passes from Brecon to Neath, and thence nearly due west through the centre of the coal measures.

The magnetic constitution of the South Staffordshire and Warwickshire coal districts is very interesting. The coal measures there appear as islands of old rocks surrounded by newer deposits. A curious horseshoe-shaped ridge line runs from the one to the other—from Bromsgrove round Birmingham to Kenilworth, then passes southward *vid* Kenilworth to Reading, and finally enters the English Channel at Chichester. It has been traced by M. Moureaux through France from the neighbourhood of Dieppe to the south of Paris.

These are perhaps the most noticeable points in the magnetic constitution of the coal-bearing districts of the United Kingdom. They do not give any countenance to the view that the magnet can be used for the discovery of coal. They do afford information as to the directions of the deviations from the normal magnetic meridian which are to be expected in the different parts of our principal coalfields.

It must, however, be remembered that the deviations are comparatively small, rarely amounting to as much as a degree, and that no magnetic map can indicate the much greater disturbances which may be produced by the immediate neighbourhood of a small magnetic rock, the effects of which would be inappreciable a few yards off. This brings us to the second part—viz.:

II.—The Distance from Masses of Basalt at which the Deviation produced by them on the Magnet would be Inappreciable.

Magnetic rocks are often permanently magnetised, and may deflect a compass held close to them through 40deg. or 50deg. The permanent magnetisation is, however, irregular, and at a comparatively short distance the disturbing effect appears to be due rather to the uniform magnetisation produced by the earth's magnetic field.

The author has made calculations on this point, based on the measurements of the magnetic properties of basalts above referred to, and during the magnetic survey special observations were made near isolated and prominent masses of trap. The general conclusions, both of theory and experiment, are (*a*) that dykes and thin uniform basaltic sheets produce no measurable effects except at distances from their edges, which are small multiples of their thickness; (*b*) that isolated masses of trap-rock a few square miles in area produce no important magnetic effects at distances comparable with their linear dimensions.

Of course, isolated cases may, and probably do, occur where one or other of these indications would be incorrect. They hold good in every case which has been specially investigated in the United Kingdom, such as the Island of Canna, near Skye, Boulmer Dyke, in Northumberland, Titterstone Clee Hill, in Shropshire, and Brent Tor, in Devonshire.

The last point on which a few words may be useful is—

III.—The Effects of Geological Faults on the Compass.

The view commonly held that faults affect the needle may in some cases have some foundation in fact. A line of magnetic attraction coincides very closely with the great fault marked by the Caledonian Canal. But though it is possible that magnetic rocks may lie nearer to the surface on one side of a fault than on the other, and that thus a magnetic disturbance may be produced, such an effect will be very small except under favourable conditions. If the throw of the fault is small compared with the depth at which the magnetic rocks occur, the compass needle will not be affected.

It is hoped that, apart from the purely scientific interest of the determination of the positions of the lines and regions which attract the north pole of the magnet, such facts and generalisations as those above indicated may be of some practical use.

* *Proceedings*, Royal Society, vol. xlvii., p. 505. 1890.

Electrolytical Process of Bleaching.—In a recent review on progress in bleaching in *Lehne's Färberzeitung*, Dr. Kielmeyer mentions an electrolytical process invented by Dr. Karl Kellner, which, whatever be its practical value, has at least the merit of being original. The necessary apparatus consists of a pair of rollers—the one iron, the other carbon—which, while rotating, are fed with an electric current by contact with wire brushes, and thus converted into the two poles of a battery. The cotton cloth before passing these rollers is saturated with brine and runs in company with an endless felt blanket, also saturated with brine, which is next to the iron roller and receives the caustic soda formed, to deliver it further on into a tank filled with salt water. The chlorine liberated at the carbon roller accumulates in the cotton fabric. On issuing from between the rollers (whereof there may be several pairs) the cloth remains rolled up for some time before it is washed to prolong the bleaching process. Whether the process has already found practical application does not appear.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE COUNCIL OF THE INSTITUTION.

The proper constitution of the Council of the Institution is one of the most complex problems with which its members have to deal. The session is now practically at an end, and one of the first duties of the Council in the autumn will be to prepare a house list—that is, a list of those members of Council whose term of office expires, and the names of those members of the Institution the Council suggest are best to fill the vacancies.

Now, in the first place, we want to point out that the Institution is not an advertising medium for cheeky commercial travellers and representatives of thirtieth-rate firms. There has been and is far too much of this kind of thing in our Institution. The men who guide the Institution are for the most part men of ability, men who have done something to educate and enlighten the profession and raise its status. The residuum are men who have no earthly right ever to have been elected, and ought never to have had their names upon the house list. Let the members look over the names and ask themselves the questions, What has this or that man done to benefit the profession generally? What papers has he written, what information has he given? Why, the very names of some stink in the nostrils of the more eminent members of the profession, and are representative of all that it is desirable to avoid. There is no necessity to elect one representative of a dozen firms who hang out the sign of "Electrical wants supplied." Fancy the Institution of Civil Engineers doing such a thing! No; there the claims of the candidates are carefully weighed, and unless of a calibre above the average standard it is hopeless to expect selection.

Some years ago it will be remembered the house list of the Council contained extra names, so that the voters could select from amongst them whom they desired to see upon the Council. This plan was found to be more or less unworkable, more we think from a phase of human nature which is rather to be commended than disparaged. All men, if they have any real grit in them, have also a vein of conceit. They do not like the idea of being candidates for a position and failing to obtain that position. Then, again, modesty is not necessarily absent from conceit, and the able man may have so lived and acted that his abilities are known to only a limited circle. If the house list is to be restricted to the exact number of the Council, it is the duty of the Council to examine the credentials of every name brought before them in the most careful manner, and to avoid accepting the name of any man who is run by an energetic clique. It is well known that individuals do court a seat on the Council—and such a seat is an honourable position; yet the system of log-rolling is not one likely to redound to the credit of the Institution. "You push me in this year and I will do the same for you next year," is not the policy of an institution which in importance and numbers should rank second only to the Institution of Civil Engineers.

The Council is nothing if not representative. This we endorse, but disagree as to the sections to be represented. We do not want representative

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tradesmen, if we do of manufacturers. There will be no elevation of the status of the profession by selecting men whose home is the shop, and whose experience is limited to the sending in of tenders and the making out of invoices. Neither do we want representatives from among that numerous body who call themselves consulting engineers without having undergone any real training for the work. The issuing of an open specification does not stamp the consulting engineer as having ability, originality, or, indeed, any views of his own at all, except a 5 per cent.—or less, if he is hankering after work—commission. We distinctly say there are consulting engineers and consulting engineers. One body consists of men of repute, of knowledge, ability, and experience; the other of men who have hung out a sign—and that is all.

It is useless to criticise when the house list is published, hence these early remarks upon a subject that is of the greatest importance to the profession. The Council is certain to encounter strong opposition if it continues its course of, say, last year, and one of the things to be avoided is the creation of an energetic opposition among the members as a body.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

DUBLIN TRAMWAYS.

SIR,—I have read your leader-writer's reply and Mr. Sellon's letter, and am sorry you should consider my previous letter discourteous. I had no such intention, but I had a feeling that you were not dealing with the question in your usual impartial manner. Are you now quite fair in stating, without giving one figure in support, "that economical and efficient operation can be best secured by a trolley wire over the centre of the car roof"?

After reading Mr. Sellon's letter, I felt constrained to say—

"Ye gods, it doth amaze me!
A thing of such a feeble temper
Should so get the start of the majestic world,
And bear the palm alone."

I do not see why I should satisfy the curiosity of Mr. Sellon, but I am quite willing to do so when he has told us who and what he is. Has he ever constructed an electric tramway? Has he ever worked an electric tramway? Has he ever had one single day's practical experience of an electric tramway?

I hope I shall not be again accused of discourtesy when I say that I have in my time read many wordy letters, but in a discussion of this kind what is wanted are facts, and I suggest to Mr. Sellon that neither in theory nor in fact can he prove that there is any less mechanical efficiency in the system as at work in South Staffordshire than in the American system.

When Mr. Sellon suggests that the adoption of the principle of the South Staffordshire system for Sackville-street would necessitate a trolley arm 40ft. to 50ft. long, he displays his ignorance of the system. One of the objects of "Dickenson's system" is to avoid the necessity of the trolley wire following the curvature of the track, and this object would be attained if the supports for the trolley wire were between the tracks.

I suggest that Mr. Sellon is quite mistaken as to an extension of the span-wire system in Leeds. Will he kindly quote his authority?—Yours, etc.,

JAMES L. OWEN.

120, Colmore-row, Birmingham.
June 4, 1895.

ELECTRIC ORGANS.

The fundamental principle by which an organ or a piano can be worked electrically at a distance from the keyboard has been known for years. Any student of elementary electromagnetics will readily devise rude means for accomplishing what is necessary to this end. There are, however, in the problem many difficulties practically when working large organs electrically, and great honour is due to Mr. R. Hope Jones for the care and time which he has devoted to the subject during the last 10 years. We were recently permitted to view the four manual organ installed by him in St. George's Church, Hanover-square. The electrical problems dealt with and successfully solved in this organ enable the organist to have a control over his instrument hitherto undreamt of. The touch required is extremely light, and the stops and couplers, although very numerous, are, by reason of their small size, extremely accessible and easy to work. The console, or key-desk, is placed in the chancel, and the organ is at the further end of the church in the gallery. The connection between the two is effected by means of a cable containing some 18,000 wires, but these are of such a small gauge that the outside diameter of the cable is only 1½in. One wire is required for each pipe. The actuating electromagnet is an exceedingly well-made piece of apparatus. It is made of about ⅛in. diameter iron bent into the form of a long horseshoe. The two poles are let into a small zinc plate, on which are the guides for the armature disc; this is a small disc of iron about the size of a threepenny-piece. In the ordinary condition it is held away from the poles by air pressure. When attracted it operates a small air-port, and disturbs the balance of the pneumatic relay, which opens the organ pipes to the wind pressure. Mr. Hope Jones claims that the zinc plates touching the iron poles protects them electrolytically from the oxidising action of the atmosphere. So little current is required that three Hellesen dry batteries are sufficient to work the organ for months.

The description of the advantages of the various couplers and combination of stops, which can be arranged beforehand on the key-desk at St. George's, would be unintelligible to anyone but an organist. We were, however, impressed with the fact that the electric organ facilitated all the operations previously possible on organs, and gave many new advantages. Still, we hope that the inventive genius of Mr. Hope Jones will not act prejudicially to the interest of the organists themselves, although we see no reason why in the near future one organist should not supply the music to the whole of the churches in London from one keyboard. The question of the time taken by the rest of the service not being quite uniform, would be the only objection. The inventor of this most admirable system is now devoting his attention to the production of sound in organ pipes by means other than wind pressure. None of these methods have so far been used at St. George's Church, but we understand that one is shortly to be tried there. It consists of an ordinary organ pipe with a flexible diaphragm at the bottom. From the centre of this a string will be hung, which is electrically pulled against a revolving resinned cylinder. The vibration will thus be imparted in the same manner as in a violin.

WHAT, WHEN, AND WHERE.

Physical Society.

June 14.—1. "The Measurement of Cyclically Varying Temperature," by H. F. Burstall. 2. "The Thermal Constants of the Elements," by N F. Deerr. 3. "An Electromagnetic Effect," by F. W. Bowden.

Society of Engineers.

June 10, 7.30 p.m.—At the Royal United Service Institution, "Safety Appliances for Elevators," by Herbert Umney.

Royal Institution, Albemarle-street, Piccadilly, W.

June 8, 9 p.m.—"Elizabethan Literature" by Prof. Dowden.
June 10, 5 p.m.—General monthly meeting.

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SOME PHYSIOLOGICAL EFFECTS EXPERIENCED IN CONTACT WITH LIVE ALTERNATING-CURRENT CIRCUITS.*

BY LUDWIG GUTMANN.

Since one of the topics of the day is the effect of the electric current, and especially alternating current, on the human body, it may be of interest to throw some further light on this question, and on those unfortunate beings who find themselves unintentionally or otherwise in the grasp of this mystic power. So far, no one who survived has satisfactorily explained his feelings, and it might be supposed erroneously that everybody would be unconscious as soon as he had established connections with a live circuit.

Having had a number of men under me doing work on such circuits, I have tried to find out from those who have experienced severe shocks what they had felt, but received replies from which no logical conclusions could be derived, with one exception—namely, regarding the length of time they believed they were in the circuit. I have found invariably that men caught on alternating-current circuits would estimate the length of time of contact a great deal longer than could be accounted for, and their statements have been contradicted and disproved by others near at hand at the time of the accident. A man who had formed part of a circuit would say he believed he was in circuit for 10 minutes, when the whole time may not have been more than as many seconds, or at the outside half a minute, as learned from the statement of others.

While trying to unravel this mystery, which I began to think was not intended to be known to man, the means of acquiring the information were accidently placed in my way. It happened this way. My experimental room was located on the first floor of the factory and divided from the main part in which light machine-work was done, by a low partition. There are some 40 or 50 men engaged on this floor, filing, hammering, fitting, turning, etc. The dynamo utilised for testing was on the ground floor, and the switch controlling this, a special circuit, temporarily arranged and brought to my room, was between my room and the transformer test-room. Having finished some determinations regarding a new type of transformer, I went out and opened the switch and returned to my room. Then I carelessly opened the connectors, not expecting that on my return to the room somebody else would close the switch again, which proved to be the case in this instance. On getting hold of the primary wire of the transformer with one hand and the circuit wire with the other and pulling them out apart from the connectors, I placed myself directly in the high-tension circuit. I was caught, the bare ends of the wire were held one in either hand, which, by the flow of current were closed, holding the wire, a No. 8 or 10 B. & S., tightly in the hands. For an instant I was stunned; when this momentary unconsciousness passed away I found myself unable to breathe, utter a cry for assistance, or move. I was spellbound in a crouching position. The noise around me in the shop seemed to be very weak; it was as if I was a block or more away, and the hammer blows, which generally made the shop so noisy, were very faint. I was not capable of thinking about myself and the danger in which I was placed. All I do remember besides the faint hammering was that I felt my arms shaken as if in the grasp of some powerful man in a playfully exaggerated hand-shake. I felt the rolling action of the current impulses as they slowly approached, just as we observe the heavy waves approaching the shore on the beach. Suddenly, the wires had burned through the skin, and in some way did not make proper contact. The current was momentarily interrupted, and I jumped up, or as this motion was a passive one on my part I was straightened out from my bent position by the relaxation of the muscles, while in doing so the dangerous wires dropped to the floor. I was free once more, and after taking a deep breath I felt a glowing heat all over my body and a weakness in the limbs, just as after a fainting spell. In spite of this trouble, which had not been noticed by anybody, I continued to work, feeling ashamed of having been caught in that way. The dynamo was a 10-pole alternator, yielding at the time 1,100 to 1,150 volts while my body was in series with the primary coil across the terminals of the generator.

With this unexpected experience at my disposal I have been able to explain a number of sensations. Of course, I must admit that the current was weak enough and the conditions favourable enough (for me) to recollect, but I believe that it was very near the limit. I could neither breathe, utter a sound, move, nor was I capable of thinking anything except the sensation to which I was subjected, as no other thoughts, not even fear for my life, or knowledge of my predicament, entered my mind at any time. All such ideas must have been dormant. This experience occupied my mind in my leisure moments, and I asked myself: Could you not have counted the alternations had you thought of it, especially as every impulse seemed so clear and distinct, such a slow rolling motion, starting in the hands and creeping up the arms, with such a long time apparently between the waves?

At first I thought I could have done it, but later I came to the conclusion that to experience and feel every impulse distinctly is one thing, and to remember, record, or integrate is an entirely different thing, leaving out of consideration the fact that the concentration or retention of such a thought of counting or attempting to count would be a questionable, if not an impossible, task under the influence of the current.

We can understand why some people think the sensation is like that of being beaten, or why I felt the severe hand and arm shaking. It is simply the result of the current on the muscles which alternately assume a state of contraction and relaxation. The strange fact that men believed to have being in circuit a considerably longer time than was actually the case can now also be accounted for; evidently, if you can clearly distinguish every impulse, the brain must be capable of counting 16,000 in a minute, even if we are not able to mechanically record it. Under these conditions a quarter of a minute would mean counting mentally to 4,000, and any man would naturally think the time must be more than five minutes.

The very fact that men have made such statements with the error in the same direction clearly shows that they were not unconscious, but that some part of their brain was temporarily disabled or paralysed.

Dr. Goelet's conclusions, derived from the examination of the body of the murderer Hampton at Sing Sing, and published in the *Electrical World* of March 16, are very logical. They should, however, not be used in a general way. There is a vast difference between an accidental contact with a live wire and especially prepared connections for executing criminals. His conclusion, however, that death is painless because "electricity travels faster than the nerves can transmit painful impulses" seems to me erroneous, believing that three times the number of alternations as used at present can still be clearly distinguished by the brain.

Death may be instantaneous if a large amount of energy is suddenly discharged through the body; it can be painless also when the apparatus is less powerful and properly applied; because a sufficient amount of energy used, while it may not cause instant death, will produce contraction or expansion of parts of the brain either by direct action of the current, or more probably by the pressure of the blood vessels on the surrounding portions of the brain, causing instantaneous unconsciousness, while death results ultimately from the decomposition of the blood; or, as these investigations have also disclosed, by the bursting of blood vessels in the brain with their well-known effects.

The statements made by Prof. D'Arsonval have proved to be incorrect as regards the executions in New York State, yet the controversy he has caused has been of incalculable value, for it has been the cause, first, of establishing the truth, and, secondly, to restore to life those or many of those who accidentally have fallen into the grasp of this invisible force. It is gratifying to know that, owing to just these controversies and the resultant instructions given, a number of hapless victims have been restored to life by artificial respiration.

* From *Electric Power* (New York).

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THE MECHANICAL PRINCIPLES OF ELECTRICAL ENGINEERING.*

I fear my address must be commenced with an apology. When I was invited to come here to-night, I had no idea of either the size of the audience it would be my duty to address, or of the magnitude of the subject I should be expected to deal with. If, therefore, this lecture is to some tedious or elementary in its character, I trust you will bear with me for the sake of the few whose technical knowledge may not have reached an advanced stage.

The relation of mechanical to electrical engineering is so close that I have found considerable difficulty in dealing with those branches of our subject verging on the borderland of the two allied sciences and classifying them as belonging distinctly to either. This must always be so, and I fear it is the one of all others that becomes the *pons asinorum* to those who at the outset of their career are called on to take charge of or erect any important work belonging to either. At the present day there is hardly a single operation of any magnitude conducted of mainly a mechanical or electrical description that does not also entail at least a rudimentary acquaintance with the elements of electrical or mechanical science respectively. Our knowledge at the present time is vast, rapidly extending, yet nevertheless so infinitely incomplete, that it cannot now be said, as once it was, that a man should know something of everything and everything about something. I do not think that it is asking too much of our electrical engineers to pay adequate attention to the principles of the mechanical side. I have no hesitation whatever in asserting that not only has everyone of our leading electrical engineers attached this aspect of the question with assiduity, but that also the extraordinary relapses in the progress of electricity in the seventies were due largely to the non-acquaintance of such knowledge by those engaged in its pursuit. The fundamental axiom of mechanical science is the same as for any other—namely, accuracy. The cultivation of judicial reasoning, powers of drawing logical conclusions, of making careful measurements, experimental work, and of handicraft, forms the basis of the education of the mechanical engineer, as it should of the electrical engineer. You are, of course, acquainted with the admirable work done to encourage such advancement in this training school, and such work is to a great extent common to that done in our great mechanical laboratories, and it merely becomes a question of diverting the existing powers that your students must already possess into suitable channels to produce a combination of electrical and mechanical knowledge before which many of our greatest difficulties are overcome. Take, for instance, the question of strength of materials. Iron (cast and wrought), steel, copper, gunmetal, and other alloys, each have their peculiar individual properties, which must be understood and appreciated before they can severally be put to the most efficient service. It may be said that the ubiquitous pocket "Molesworth" can supply this knowledge, but the distinguished author of this valuable little work would not for a moment pretend that it should replace the training of the student, and, in fact, it would be as dangerous in the hands of such a one as would be the "British Pharmacopœia" in the restless hands of the chairman of the London County Council. The student must be trained how and when to apply the formulæ and constants supplied in text-books, and such information is as vital in the design of a dynamo as it is in that of a steam engine or boiler. To obtain such training there is only one royal road, and that is by actual study of the subject from the theoretical as well as the experimental aspect.

I have referred to the question of material as of importance, and as an example I will give you a general outline of the various forms and properties possessed by iron and its commoner compounds. Pure iron is unknown to the engineer, and what is generally called iron is classified into five main groups, distinguished the one from the other by the physical properties and chemical constituents. These five classes of iron compounds are often referred to as (1) weld iron; (2) weld steel; (3) ingot iron; (4) ingot steel; (5) pig iron. (1) Weld or wrought iron will not sensibly harden and temper, can be forged and welded, contains 0·0 to 0 6 per cent. carbon, and is manufactured from any forms of iron not in a fluid state. (2) Weld steel, or puddled steel, is distinguished from weld iron, insomuch as it will harden and temper and contains 0·6 to 3·0 per cent. carbon. (3) Ingot iron differs from weld iron, insomuch as it has been cast from a fluid state into malleable masses; carbon, 0·0 to 0·6 per cent. (4) Ingot steel is also cast from the fluid state, will temper on quenching, and contains 0·6 to 3 0 per cent. carbon. (5) Pig iron is cast from fluid state in two forms—namely, white and grey—containing amorphic carbon only, or with graphite to the extent of 5 or 6 per cent., and frequently 5 per cent. of silicon manganese sulphur in addition. It is brittle, and cannot be welded or tempered.

From the foregoing notes it may have been observed that steel is merely an impure form of iron, which, in consequence of the presence of the other elements, has the property of hardening on being quenched; and although the main impurity is very frequently carbon, this is not always so, since iron alloys of tungsten, chromium, titanium, manganese, etc., exist, and the alloy or mixture is still called steel. The proportion and nature of even a minute impurity influences the useful properties of steel enormously. For instance, for boilers, ship plates, girder plates, etc., a steel containing 0·05 to 2·0 carbon is commonly used, having tensile strength 25 to 32 tons per square inch, extension 20 to 27 per cent.; for making railway axles, tyres, rails, guns, and heavily-stressed parts, a steel containing 0 2 to 0·35 per cent. carbon, standing 32 to 38 tons per square inch, and with an extension 15 to 20 per cent. For springs, guide-bars of engines, and pieces subject to friction, such as shafts, steel is used containing 0·35 to 0·5 carbon, tensile strength 38 to 46 tons per square inch, extension 15 to 20 per cent. in 8in. Or, again, for tools, as much as 0·5 to 0·6 per cent. carbon is used, and in this case the tensile stress equals 46 to 51 tons, but the extension is only 5 to 10 per cent. It is also a matter of importance to know that permanent magnets are made of the hardest tool steel, whereas the purest soft wrought iron has the greater permeability, and the conductivity of the latter is also slightly greater than steel, being about 15 to 20 per cent. of that of copper. Although the apparent difference between tool steels and pure wrought iron is merely due to the presence of about 0·5 per cent. carbon, the latter may stand more than twice the ultimate breaking load of the former.

In comparing the results of tests with the chemical constitution of the material, it will be found that, in general, elements which increase the tenacity will also decrease ductility and resilience. Thus, carbon increases strength up to a limit beyond which an excess begins to weaken it, as at the limit which separates steel from cast iron, but every addition of strength takes place at the sacrifice of that ductility which is an essential property of good iron. Phosphorus adds strength, as do manganese and other less common constituents, but in most cases a limit to increasing strength is reached, and is accompanied by a noticeable loss of ductility. It sometimes happens that the elastic resilience increases with addition of such elements up to a limit, which limit is, however, reached usually long before the increase of strength ceases.

I have dwelt at some length on the properties of one single common material of construction for no other purpose than to show how essentially divergent such properties are, even in substantially one material under different conditions. It is obvious from this that the uses to which the various forms can be put must be totally variant, and, therefore, it behoves the electrical engineer to be acquainted with the properties, and to know how to test the material to ensure that when he has ordered a given quality he is getting what is requisite. The following is the test for Hadfield's manganese steel (10 per cent. manganese). Test piece forged and quenched, not turned. Usually 1 per cent. manganese makes steel useless for constructive purposes, but with 10 per cent. the alloy is too hard for

* An address delivered to the students at the Croydon County Polytechnic by Mr. H. B. Ransom, A.M.I.C.E.

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filing, is very ductile, and as strong in tension as the best crucible steel. It apparently does not exist in a state of ease, for a permanent set begins almost at once on testing. The specimen was 10in. long and 0·855in. in diameter. The limit of elasticity 60,000lb. = 26·8 tons, so that the extension = 0·07in., or $35{\cdot}5\frac{1}{1000}$in. At 120,000lb. stress the strain = 2·66in., and was still unbroken; in fact, the testing machine then broke. A remarkably good iron tested under similar conditions had its limit at 16·05 tons, with extension of $19\frac{1}{1000}$in., and broke at 39·1 tons per square inch fractured area, or 24·5 tons per square inch original area, with a total extension of 2·356in. Thus manganese steel is an exception to the general rule, inasmuch as its tenacity exceeds that of best crucible steel, and its elasticity and ductility exceed that of wrought iron. The proportion of foreign matter present in its composition is so large, however, as to make doubtful whether it ought to be included in the list of steels.

The testing machines in which these strength of material experiments are made are simply modifications of the ordinary steelyard weighing-machines, in which the load applied to the test piece is equivalent to the cartload of coal to be weighed, and the test piece is arranged so as to act merely as a link connecting the weighbridge with the steelyard. The load is commonly applied by means of an hydraulic ram and an accumulator, so as to regulate easily and to a nicety the stress on the test piece. By very trifling modifications, it is easy to see how the same machine can be used for testing the strength of materials as beams, or in compression, as well as in tension. For tensional experiments, it is preferable to use a separate machine which may be of much simpler construction. There are a considerable number of designs for testing machines, and something of the sort is usually considered to be an almost indispensable adjunct to an engineering laboratory. Among others, may be mentioned that of Mr. A. H. Emery, designed for the United States Board appointed to test materials for their navy. This machine can test specimens from 1ft. to 30ft. long and 30in. wide, and on trial before acceptance was tested as follows: A hard wrought-iron link 5in. was slowly strained in tension, and broke at 722,800lb. A horse-hair was next tested $\frac{7}{1000}$in. diameter; it stretched 30 per cent., and broke at 1lb. Other machines have been designed by Wicksteed, Greenwood and Batley, Kirkaldy, Thurston, etc., and in most of these, if not all, stresses of 100,000lb. may be measured to a pound or so. The extension, contraction, or deflection of a test is measured by a separate gear attached to the test piece itself, and is usually capable of detecting and, if need be, recording changes of form of $\frac{1}{1000}$in. It is, of course, equally important to take the dimensions of the test piece before and after testing, and for this purpose various little instruments depending on the vernier for accuracy have been devised which may generally be relied on to the $\frac{1}{1000}$in. also.

The points to be noticed on the stress-strain diagrams are: stress = molecular resistance to disruption under application of external load, measured in pounds per square inch area; strain = distortion due to external load, measured usually in $\frac{1}{1000}$in.; specific extension or compression = mean extension in $\frac{1}{1000}$in. for 1,000lb. stress. Limit of elasticity is reached under minimum load so great as to prevent the return of test piece to original form on removal of load. Each material has clearly defined limit, specific extension, and modulus. Another feature of iron under stress is that it cools on being strained under its limit, and heats on being strained over its limit; *vice versâ*, on being released below its limit it heats. This may be readily ascertained by simple electrical experiments, using thermopile and galvanometer, and tells us that there is no molecular friction below limit and there is above the limit.

The three forms of stress are tensile, compressive, and shearing. Bars in tension, or ties, are in a state of stable equilibrium—that is to say, if bent, tension would tend to restore the bar; but the contrary is true with struts. Although compressive stress is mathematically merely equivalent to negative tensile stress, the effect on the material is very different. For instance, the stress in a tie is almost independent of its length; but length is a very important factor in the construction of struts. Again, the mode in which a strut is held at the ends influences its resistance to buckling enormously. Shearing stress is produced by the action of two equal and opposite couples, and its effect is to slide one molecule over another. The stress per square inch may be uniform over a given section, or variable; the latter case occurs in beams and shafts. The strength of beams does not necessarily vary as the area, but the stress on any small area is proportional to the area multiplied by its distance from the neutral line. It was found by Hooke that stress was proportional to strain up to a certain point, and therefore one may expect that a stress-strain diagram will be for some distance a straight line. Hooke's law is only true below the limit of elasticity, and then only when stresses are gradually increased. Cast iron is peculiar in its behaviour in tension; it often stretches twice as much as wrought iron for same load, and then suddenly breaks with none of the usual intermediate stages. Materials are always designed to carry loads beneath the elastic limit, and, therefore, for purposes of calculation we can assume Hooke's law to be true. For tension, let spec. stretch = e = stretch in $\frac{1}{1000}$in. in a bar 10in. long, under a stress of 1,000lb. per square inch.

For wrought iron $e = 0{\cdot}3$ to $0{\cdot}33$, cast iron $e = 0{\cdot}7$ to $0{\cdot}8$.

Let x = extension in inches in a length of l inches under a stress of s pounds per square inch.

Then $$e = (x \times 1{,}000) \times \frac{1{,}000}{s} \times \frac{10}{l} = 10^7 \frac{x}{sl}.$$

As e is constant for a given material, then $\frac{x}{sl}$ is constant,

and $\therefore \frac{sl}{x}$ is constant. $\frac{sl}{x} = \mathrm{E} =$ Young's modulus.

$$e = \frac{10^7}{\mathrm{E}}, \text{ or } \frac{\mathrm{E}}{s} = \frac{l}{x};$$

and $\therefore$ if $\mathrm{E} = s$, then $l = x$.

$\therefore$ E = stress in pounds per square inch,

which would double original length of a bar following Hooke's law.

Young's stretch modulus is a figure of great importance used in calculations relating to beams, arched ribs; and from a number of experiments I have made it varies from

7,500,000 to 15,000,000 for cast iron.
25,000,000 to 30,000,000 for wrought iron.
25,000,000 to 32,000,000 for steel.
12,000,000 to 14,000,000 for gunmetal.
12,500,000 to 17,000,000 for copper.

Fractures are often taken as indicating good or bad iron, but they are very deceptive and vary enormously in appearance according to the precise way in which the metal is broken.

Repeated loading as a mode of test is useful in the extreme, but comparatively little is known about it. In Wohler and Spangenberg's experiments, the wrought-iron test piece broke at 48,000lb. per square inch, and was tested by rotating with heavy load at one end. Rupture may be caused, not only by a steady load which exceeds the carrying power of a material, but also by repeated applications of stresses, none of which are equal to the carrying strength. The differences of these stresses are measures of the disturbance of the continuity, in so far as by their increase the maximum stress which is still necessary for rupture diminishes. For struts 30 or 40 diameters in length buckling occurs at definite points, but if the ratio $\frac{l}{d} = \frac{80}{1}$, or $\frac{100}{1}$, the strut buckles at very low loads. In the latter case the strut strength is in independent of strength of material, but is proportional, other things being equal, to its modulus of elasticity. For short struts the resistance to buckling depends on distance between points of contrary flexure. The problems relating to beams are too complex to be dealt with in a few minutes, and I will therefore leave the question concerning strength of materials and pass on to one which is no less interesting—namely, motive-power generation; but before so doing I may be allowed to express a hope that my words have been sufficient to show young electrical students that materials such as iron cannot be safely used in ignorance of all their properties.

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To generate electricity on a large scale, it is at present essential that the electric generator should receive, in the first place, its motive power from some source not directly involving the use of electricity. This may be done by steam engines and boilers, or refuse destructors, gas-engines using town's gas or producer gas, turbines driven by water power. To Rumford, Joule, and others should be given the credit of having first established and defined the relations between electrical energy and mechanical energy, and also between mechanical energy and heat energy. The historical experiments of the paddle-wheel and falling weight, culminating in the mechanical equivalent of heat called Joule's equivalent (J = 772 foot-pounds = 1 thermal unit) must be familiar to all. Heat and mechanical energy are mutually convertible, and heat requires for its production, and produces by its disappearance, mechanical energy in the proportion of 772 foot-pounds per British thermal unit. It is interesting to note that although Joule was the first to bring this figure into prominence, Carnot published in 1824 a work entitled "Reflexions sur la Puissance Moteur de Feu," in which he arrived at the conclusion that heat and mechanical energy were convertible, and had actually obtained a correct value of the mechanical equivalent of heat, whereas Joule's second series of experiments were only published in *Philosophical Transactions*, 1848-1850, and British Association, 1867. Although 772 foot-pounds is commonly taken as the value of J, the time cannot be far distant before this figure must be revised. Joule himself showed by later experiments with electrical apparatus that 782 was more accurate, and subsequent observers have fixed it at about 780. The electrical experiments of Joule are interesting, as forming a connecting link between electrical energy and heat energy, from which has been derived the equation 1,000 watts = $1\frac{1}{3}$ h.p.

The relation between heat, work, and electricity being established, we have next to consider the manner in which such transformations of energy are accomplished. Assuming for the moment that heat is contained in a gas, how is that heat going to be practically converted into foot-pounds? In the first place, this problem cannot always be solved at all, and in all cases the efficiency is very low. For instance, the thermo-dynamic efficiency may be only ·08, and the mechanical efficiency 0·5, leaving a combined efficiency of $3\frac{1}{2}$ per cent. Theoretically, all the heat should be received at one temperature, T_1, and rejected at one temperature, T_2. The temperature being a measure of the heat contained in a given body of known weight, the thermo-dynamic efficiency is $\frac{T_1 - T_2}{T_1}$. But T_1 T_2 must be measured in absolute temperature—*i.e.*, deg. F. + 461deg.

In the case of a steam engine and boiler the water is received at 60deg. F., say, and is raised to 360deg. F., receiving heat the whole time, the greater part during its conversion from water to steam at constant temperature. Again, only a portion of the heat contained in the steam can be converted into work, because the water cannot be reduced to a temperature of absolute zero. Although steam-engines have been mentioned, there is no difference in principle between steam and air or gas engines. In the steam-engine the working fluid starts as a liquid occupying a small volume, is converted into a gas occupying a very large volume, and, lastly, is changed into a liquid again, whereas in an air-engine the working fluid remains always gaseous and occupies a large volume. The advantage of air or gas engines lies in the fact, that in dealing with air or gas the pressure is not necessarily a function of the temperature. Hence, the theoretical efficiency, $\frac{T_1 - T_2}{T_1}$, may be very great because T_1 may be very great and T_2 small. An air-engine may have a theoretical efficiency of 0·75, but its actual efficiency may be only 0·1, because the difficulty of getting metals to stand at 3,000deg. F. or more is obviously great. A steam-engine may have a theoretical efficiency of only 10·3, but its actual efficiency will perhaps be 0·2. There are certain obvious advantages in connection with gas-engines which make them very attractive. Gas is far more easily oxidised than coal, and the boiler and steam-engine cylinder being rolled into one cylinder, so to speak, the convenience of the combination is great. The difficulties of gas-engine manufacturers are being overcome, and at the present time the Belfast Corporation have completed an electric light installation in which the engines receive their motive power entirely from gas.

I do not propose now to dwell on the relative merits of steam and gas propulsion, but would prefer to describe the ways and means by which the commonest source of motive power—namely, the steam engine and boiler—may be properly tested. I take this because it does not fall strictly within the province of the electrical engineer to design the engines, but it frequently becomes his duty to test the efficiency of the motive-power plant under his control. Steam-engine testing must be treated apart from boiler testing; for the latter is tested by the coal it consumes and the water it evaporates, whereas the other is efficient or otherwise according to the steam consumed per unit of work done. To find the heat received by the engine, the amount of water which the engine receives as steam must be measured, and the amount of heat which it has received calculated. This may be done in several ways. The feed water passed into boiler may be weighed, the temperature of evaporation is given by the pressure gauge, and the temperature of feed found by ordinary thermometer. Of course, the water level and steam pressure in boiler must be the same at commencement and end of trial, or else the difference must be allowed for. An engine trial should not be less than two hours, and should preferably be four or six hours; and readings of all the feed measuring instruments should be taken frequently—say, every 10 minutes or quarter of an hour. Frequently the feed water cannot be weighed directly, and then a weir, notch, or tumbling bay may be used; and although this device does not lead to direct measurement, it is one which we are compelled to adopt occasionally owing to the large quantities of water to be dealt with.

We have in this way obtained water supplied and heat added to convert it into steam. This, then, is work put into the engine, provided that all leakages from pipes, valves, etc., and steam consumed by pumps, etc., have been carefully measured and debited. The gross work performed by the engine is measured by the indicator diagram, and is called the indicated horse-power. This indicator should be fixed as closely as possible to cylinder, and be without bends or elbows.

In making engine trials of this description, the greatest care has to be taken to collect all drip cock, blow-off-cock, cylinder waste, etc. If practicable, the cylinder exhaust steam should be caught and weighed; this can easily be done with surface-condensing engines, and also with jet-condensing engines, but in the latter case condensing water must be measured in addition. In steam-jacketed engines a special record has to be kept of condensed steam from jackets also. In boiler testing, notes should be taken of temperature of furnace gases as they leave the boiler every 10 minutes, and also notes of damper opening. Gas and air samples should be collected two or three times during trial. Air samples give amount of moisture contained, tested by passing through calcium tube. Gas collecting should go on for half-hour at time through perforated collector in chimney. Measure volumes under known pressures and temperature, and test for CO_2 with calcic chloride. Decrease of volume of mixture when under same pressure tells how much absorption of CO_2 has taken place. A fresh sample, tested with pyrogallic acid, should give O present. Other boiler-house measurements should give coal used, ash collected, water levels, steam pressures, feed-valve openings, times, etc. Coal and ash samples should also be tested for calorific value and complete combustion, etc. Complete balance-sheet for trial should be drawn up, stating total heat received, how expended, and where losses have been made. Sheets of this character will be found in the Royal Agricultural Society's engine trial reports.

To illustrate another branch of applied science now usually taught in engineering schools, I give a few notes relating to the dynamics of a complicated mechanism. It matters not whether the particular machine be one used for electrical work or for any other purpose,

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the principles involved in the one will be the same as those involved in the other, and the advantages gained in both cases will be equal. When any machine is put in motion, there are obviously stresses set up due to momentum and centrifugal force, etc., and it therefore becomes a matter of great importance to know precisely what these stresses amount to. These stresses may, of course, be calculated by pure mathematics, or the comparatively new science of the graphical calculus may be substituted to deal with the question. Another feature which this investigation shows is one which is of great importance to electrical engineers. It is of importance to get uniformity of motion of rotation. Such uniformity is impossible with the ordinary slider crank mechanism. The influence of both flywheel and governor is noticeable.

A highly interesting and attractive topic is the utilisation of the heat obtained from refuse destructors. It is almost impossible to say exactly what calorific value to attach to any given load of refuse, but it is tolerably easy to calculate from easily ascertained data the limit which it is impossible for it to exceed. There are three factors to be considered: (1) the combustible portion; (2) the incombustible; (3) the moisture. The calorific value of the combustible portion will certainly not exceed that of coal, consequently its limit is determined. The incombustible proportion may be ascertained by burning a given weight of the mixture in a neighbouring furnace, and the moisture may be ascertained by weighing the load before and after drying. These quantities can be ascertained at various periods of the year, and the amount of variation of each factor will give an idea of the fluctuation in calorific value at the different seasons. The heat generated by the combustion of a load of the mixture is utilised in three distinct ways: (1) in evaporating water in a boiler for useful purposes; (2) in evaporating its own moisture prior to its combustion; (3) in heating and fluxing the incombustible portion, the bulk of which heat is withdrawn from the furnace, when the clinkers are extracted. We will now take as an illustration a refuse containing 50 per cent. combustible, 25 per cent. clinker, and 25 per cent. moisture. (A very good sample.)

$\therefore$ 1lb. refuse contains $\frac{1}{4}$lb. water.
" " $\frac{1}{4}$lb. clinker.
" " $\frac{1}{2}$lb. combustible.

The heat theoretically required to evaporate $\frac{1}{4}$lb. water from 60deg. F. at 212deg. F. $= \frac{1,116}{4}$ B.T.U. $= 279$ B.T.U.

The heat lost in forming the clinker that is withdrawn will be about the same as that required for the melting iron in a cupola, or about $\frac{1}{4}$lb. coal to a $\frac{1}{4}$lb. clinker. If the calorific value of coal be taken at 14,500 B.T.U., then 1,825 B.T.U. are lost in clinker. The combustible portion will certainly be inferior to coal, and therefore will not contain more than 7,250 B.T.U. Hence the maximum net calorific value of 1lb. of refuse $= 7,250 - (1,825 + 279)$ B.T.U.

$= 5,146$ B.T.U.

Now, suppose this refuse could be burnt in a first-rate boiler, evaporating 10lb. water per 1lb. coal, then the gross evaporation would only amount to 3·5lb. per 1lb. This figure has been obtained (1) by selecting a refuse containing an exceptionally large proportion of combustible material; (2) by assuming the combustible portion equal to good coal, which it never is; (3) by assuming that the refuse can be burnt directly under a good boiler. We may therefore fairly assume that average refuse, as it is now collected in English towns, never can evaporate as much as 3·5lb. water from 60deg. at 212deg. F. per 1lb. refuse. If, on the other hand, a rather poorer refuse than the foregoing be considered, containing, say, 40 per cent. moisture and 30 per cent. incombustible, then under the same conditions and assumptions it may be found that 1lb. of refuse, at a maximum efficiency, can only evaporate 1·1lb. water. It is noteworthy that in the latter case the combustible portion of the refuse is bound to have a calorific value equivalent to 60 per cent. of that of good coal, otherwise the refuse would not burn without screening or the addition of more combustible fuel. This mode of calculation is, of course, only useful inasmuch as it leads us to a knowledge of the maximum evaporative power of a given refuse, beyond which it is absolutely impossible to get. These figures do not depend on the particular furnace in which the refuse is burned, and they, therefore, clearly demonstrate the absurdity of putting forward as fair average practice such high evaporative efficiencies as have been of late so freely circulated in the Press. They also show something more. Assume, for instance, that as much as 1lb. water can be evaporated per 1lb. refuse, and that a collection of 80 tons per diem be made. Then the water evaporated per hour is only $\frac{80 \times 2,240}{20}$lb. $= 7,466$lb., which may be taken as equivalent to about 300 b.h.p. per hour. A district containing 100,000 inhabitants might produce this refuse, and it has been said that this refuse would be sufficient to furnish light to the locality. Even the initial central station would probably be erected to supply a maximum of 400 units, or about 550 e.h.p., so that such a destructor by itself would be unable to account for much more than half the steam even at the inauguration of the installation. It is therefore clear that destructors, by themselves, can never do more than aid in the production of electric light. There are, however, very few purposes for which power is required continuously during the whole 24 hours, and this is, of course, especially true in the case of electric lighting. Thus it has been generally found that the lighting demand but rarely exceeds the average daily demand for more than eight hours except on very foggy days. Hence, if some means could be found for storing up the continuously generated energy of the destructor during the 16 hours' light load, we should then be in a position to supply three times the average power during the eight hours' heavy load.

(To be continued.)

BOARD OF TRADE REGULATIONS.

We give below the new regulations about to be issued by the Board of Trade. It will be noticed that suggestions are asked for, and we shall be glad to receive from our readers letters ventilating any new departure from the old code.

Botolph House, Eastcheap, London, E.C.
URGENT AND IMPORTANT. 30th May, 1895.

ELECTRICAL TRADE SECTION.

Revised Board of Trade Regulations under Electric Lighting Acts, 1882 and 1888.

Dear Sir,—You will doubtless have seen a copy of the revised "Regulations and Conditions for Ensuring a Proper and Sufficient Supply of Electrical Energy made by the Board of Trade under the Provisions of the Electric Lighting Acts 1882 and 1888." The above trade section of this Chamber have had these regulations under their consideration, and think it desirable that the views of central-station engineers and others interested should be obtained before representations are made to the Board of Trade on the subject. We shall, therefore, esteem it a favour if you will kindly give these regulations your consideration, and send the secretary of the Chamber at your earliest convenience any suggestions you may have to offer. A meeting of the section will be held on Tuesday, the 11th June, at 12 noon, to consider the regulations and any suggestions made, and to determine the nature of the representations to the Board of Trade.—Yours faithfully,

E. GARCKE, Chairman of Section.
KENRIC B. MURRAY, Secretary.

REGULATIONS AND CONDITIONS FOR SECURING THE SAFETY OF THE PUBLIC AND FOR ENSURING A PROPER AND SUFFICIENT SUPPLY OF ELECTRICAL ENERGY, MADE BY THE BOARD OF TRADE UNDER THE PROVISIONS OF THE ELECTRIC LIGHTING ACTS, 1882 AND 1888, AND OF THE —— ORDER.

Definitions.

In the following regulations:

The expression "the order" means the —— order.

The expression "the undertakers" means the undertakers for the purpose of the order.

The expression "consumer's wires" means any electric lines

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on a consumer's premises which are connected with the service lines of the undertakers at the consumer's terminals.

The expression "aerial line" means any electric line which is placed above ground and in the open air.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth, pressure on any alternating-current system being taken to be the equivalent of pressure on a continuous-current system when it produces an equal heating effect if applied to the ends of a thin stretched wire or carbon filament; and (*a*) where the conditions of the supply are such that the pressure cannot at any time exceed 300 volts if continuous, or the equivalent of 150 volts, if alternating, the supply shall be deemed a low-pressure supply; (*b*) where the conditions of the supply are such that the pressure may exceed the limits of a low-pressure supply, but cannot exceed 3,000 volts, or the equivalent of 3,000 volts, whether continuous or alternating, the supply shall be deemed a high-pressure supply; (*c*) where the conditions of the supply are such that the pressure may on either system exceed 3,000 volts, or the equivalent of 3,000 volts, the supply shall be deemed an extra high-pressure supply.

Mains, service lines, and other conductors and apparatus are referred to as low-pressure, high-pressure, and extra high-pressure mains, etc., according to the conditions of the supply delivered through the same or particular portions thereof.

Where these regulations require any metallic body to be "efficiently connected with earth," it shall be connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of electrical energy.

Other expressions to which meanings are assigned in the order or principal Act have the same respective meanings in these regulations.

A.—Regulations as to Safety.

I.—*General.*

(1) Save as hereinafter provided, the supply of energy delivered to the consumer's terminals shall be a low-pressure supply.

(2) A high-pressure supply shall not be delivered to any consumer's terminals, except for special purposes, and with the approval of the Board of Trade on the joint application of the consumer and the undertakers, and subject to such further regulations as the Board of Trade may from time to time prescribe. But a high-pressure supply may be given to distributing or converting stations or to transforming apparatus on a consumer's premises in accordance with the following regulations.

(3) An extra high-pressure supply shall not be given except to distributing stations or other premises in the sole occupation of the undertakers, and with the written consent of the Board of Trade, and subject to such regulations and conditions as the Board may prescribe.

(4) No high-pressure electric line shall be used for the transmission of more than 200,000 watts, or in the case of an aerial line 50,000 watts, except with the consent in writing of the Board of Trade, and efficient means shall be provided to prevent this limit being at any time exceeded.

(5) Every high-pressure electric line, conductor, or other apparatus shall be protected by a suitable automatic quick-acting cut-off.

(6) In every case where any transforming apparatus is used to convert a high-pressure supply into a low-pressure supply, some suitable automatic and quick-acting means shall be provided to protect the low-pressure system from any accidental contact with or leakage from the high-pressure system, either within or without the transforming apparatus.

(7) The maximum working current in any conductor shall not be sufficient to raise the temperature of the conductor or any part thereof to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such temperature to a greater extent than 30deg. F.; and efficient automatic means shall be provided which will render it impossible for this maximum working current to exceed such limit to the extent of 50 per cent., even for short intervals of time; and special care shall be taken that the cross-sectional area and conductivity at joints are sufficient to avoid local heating, and that the joints are protected against corrosion.

(8) The sectional area of the conductor in any electric line laid or erected in any street shall not be less than the area of a circle of 1-10in. diameter, and when the conductor is formed of a strand of wires each separate wire shall be at least as large as No. 20 standard wire gauge.

(9) Every electric line shall be tested for insulation after having been placed in position, the testing pressure being at least 200 volts, and the undertakers shall duly record the results of the tests of each line or section of a line. No electric line shall be brought into use in which this test indicates an insulation resistance less than at the rate of 100,000 ohms per mile for every volt of pressure of the supply, unless it is connected with earth with the consent of the Board of Trade, in which case the insulation resistance of such electric line shall not be less than 10 megohms.

(10) The insulation of every complete circuit used for the supply of energy, including all machinery, apparatus, and devices forming part of, or in connection with, such circuit, shall be so maintained that the leakage current shall not under any conditions exceed one-thousandth part of the maximum supply current; and suitable means shall be provided for the immediate indication and localisation of faults of insulation. Every such fault shall be remedied without delay. Every such circuit shall be tested for insulation at least once in every week, and the undertakers shall duly record the results of such testings. Provided that where the Board of Trade have approved of any part of any electric current being connected with earth, the provisions of this regulation shall not apply to such circuit so long as such connection exists.

(11) All material used for insulating electric lines or apparatus shall be of the best quality, and thoroughly durable and efficient, having regard to the conditions of its use. Suitable provision shall be made for the protection of the insulating material against injury or removal.

(12) Every high-pressure conductor shall be continuously covered with insulating material to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulating material shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. If this protection be wholly or partly metallic, it shall be efficiently connected with earth.

(13) No electric line, machine, device, or apparatus intended to form part of, or be connected with, a high-pressure circuit shall be brought into use unless the insulation thereof has withstood the continuous application during one hour of twice the pressure to which it is intended to be subjected in use. The undertakers shall duly record the results of such test.

(14) Where any portion of any electric line or any support for an electric line is exposed in such a position as to be liable to injury from lightning, it shall be efficiently protected against such injury.

(15) Where any accident by fire or explosion, or any accident causing or likely to have caused personal injury occurs at any part of any electric line or work to which these regulations apply, the undertakers shall give immediate notice thereof to the Board of Trade.

II.—*Aerial Lines where Erected with the Necessary Consents.*

(16) Every aerial line shall be attached to supports at intervals not exceeding 200ft. where the direction of the line is straight, or 150ft. where this direction is curved, or where the line makes a horizontal angle at the point of support.

(17) Every support of aerial lines shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the lines, or unequal lengths of span. The factor of safety for the lines and suspending wires shall be at least 6 and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50lb. per square foot. No addition need be made for a possible accumulation of snow. Every support if of metal shall be efficiently connected with earth.

(18) Aerial lines shall be attached to insulators, and shall be so guarded that they cannot fall away from the support. Conductors covered with insulating material shall not be attached to the insulators by metal binders.

(19) An aerial line shall not in any part thereof be at a less height from the ground than 18ft., or where it crosses a street 30ft. [*Note.*—In the county of London 35ft.], or within 5ft. measured horizontally, or 7ft. measured vertically, from any building or erection other than a support for the line, except where brought into a building for the purpose of supply.

(20) Service lines from aerial lines shall be led as directly as possible to insulators firmly attached to some portion of the consumer's premises which is not accessible to any person without the use of a ladder or other special appliance, and from this point of attachment they shall be enclosed and protected in accordance with the regulations hereinafter contained as to service lines on the consumer's premises. Every portion of any service line which is outside a building but is within 7ft. from such building shall be completely enclosed in stout india-rubber tubing.

(21) Where an aerial line crosses a street, the angle between such line and the direction of the street at the place of such crossing shall not be less than 60deg., and the spans shall be as short as possible.

(22) Where an aerial line crosses, or is in proximity to, any metallic substance, precautions shall be taken by the undertakers against the possibility of their line coming into contact with such metallic substance, or of such metallic substance coming into contact with their line by breakage or otherwise.

(23) Every high-pressure aerial line shall be efficiently suspended by means of insulating ligaments to supending wires, so that the weight of the line does not produce any sensible

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stress in the direction of its length. All suspending wires, if of iron or steel, shall be galvanised.

(24) In the case of any aerial line exceeding one-half mile in total length, means shall be provided whereby the pressure may be discharged from any portion of such line erected over or alongside of any building or buildings without loss of time in case of fire or other emergency.

(25) Every aerial line, including its supports and all the structural parts and electrical appliances and devices belonging to or connected with such line, shall be duly and efficiently supervised and maintained as regards both electrical and mechanical conditions.

(26) An aerial line shall not be permitted to remain erected after it has ceased to be used for the supply of energy, unless the undertakers intend within a reasonable time again to take it into use.

III.—*Electric Lines other than Aerial Lines.*

(27) All conduits, pipes, or casings used as receptacles for electric lines shall be constructed of durable material, and of ample strength to prevent damage from heavy traffic, and where they are laid in streets in which gas-mains are also laid shall be so constructed as to prevent any influx of gas from the adjacent soil.

(28) Where any electric line crosses, or is in proximity to, any metallic substance, special precautions shall be taken by the undertakers against the possibility of any electrical discharge to the metallic substance from their line or from any metal conduit pipe or casing enclosing their line.

(29) All metal conduits, pipes, or casings containing any electric line shall be efficiently connected with earth, and shall be so jointed and connected across all street boxes and other openings as to make good electrical connection throughout their whole length.

(30) Where isolated lengths of metal conduit, pipe, or casing are used for the protection of any electric line at road crossings or similar positions, there shall be interposed between such electric line and the conduit, pipe, or casing such additional insulating material as will prevent the possibility of any electrical charging thereof.

(31) Where the conductors of electric lines placed in any conduit are not continuously covered with insulating material they shall be securely fixed in position, and no unfixed material of a conducting nature shall be contained in the conduit. Adequate precautions shall also be taken to ensure that no accumulation of water shall take place in any part of the conduit, and to prevent any access of moisture to the conductors or the insulators, and the latter shall be so disposed that they can be readily inspected.

(32) Any portions of any high-pressure electric lines placed above the surface of the ground or in any subway shall be completely enclosed either in a highly-glazed porcelain tube embedded in brickwork, masonry, or cement concrete, or in strong metal casing efficiently connected with earth, and so protected and guarded as to prevent accidental contact with the casing.

(33) Every high-pressure electric line transmitting more than 50,000 watts, or used for the supply of energy to transformers placed in street boxes, shall, except within the generating station, be entirely enclosed in strong metal casing efficiently connected with earth, and such casing shall not contain any low-pressure electric line.

(34) High-pressure electric lines not intended to transmit more than 50,000 watts may be enclosed either as provided in the preceding regulation, or in glazed stoneware casings properly laid and jointed in cement at a depth of not less than 2ft. below the surface of the ground and sufficiently protected against breakage.

IV.—*Street Boxes.*

(35) All street boxes which contain any vacant space shall be so constructed as to prevent any influx of gas or water either from the adjacent soil or by means of any pipes, and ample provision shall be made by ventilation or otherwise for the immediate escape of any gas which may by accident have obtained access to the box and for the prevention of danger from sparking.

(36) The covers of street boxes shall be properly secured, and shall, where the box contains high-pressure apparatus, be connected to strips of metal laid immediately underneath the adjacent roadway or pavement.

(37) The casing of any high-pressure electric lines shall be continued within street boxes.

V.—*Converting Stations.*

(38) All converting stations, or points in a system of distribution to which a high-pressure supply is given from generating stations, and from which a low-pressure supply is given to consumers, shall be established in suitable places which are in the sole occupation and charge of the undertakers.

VI.—*Consumer's Premises.*

(39) The undertakers shall be responsible for all electric lines, fittings, and apparatus belonging to them, or under their control, which may be upon the consumer's premises being maintained in a safe condition and in all respects fit for supplying energy.

(40) In delivering the energy to the consumer's terminals the undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises.

(41) A suitable safety fuse or other automatic disconnector shall be inserted in each service line as close as possible to the point of entry to any consumer's premises, and contained within a suitable locked receptacle of fireproof construction.

(42) All low-pressure electric lines and apparatus placed on any consumer's premises shall be highly insulated and thoroughly protected against injury to the insulation or access of moisture, and no metal forming part of the electric circuit shall be exposed so that it can be touched. All electric lines shall be so fixed and protected as to prevent the possibility of electrical discharge to any adjacent metallic substance.

(43) Where transformers are installed within buildings on consumers' premises, they shall be contained in a fireproof chamber securely locked, and the high-pressure service lines in highly-glazed porcelain tubes bedded in chases cut in brickwork or masonry.

(44) If the undertakers are reasonably satisfied, after making all proper examination by testing or otherwise, that a connection with the earth exists at some part of a circuit of such resistance as to be a source of danger, and that such connection does not exist at any part of the circuit belonging to the undertakers, then and in such case any officer of the undertakers, duly authorised by them in writing, or, if the undertakers so require, an electric inspector may, for the purpose of discovering whether such connection with the earth exists at any part of a circuit within or upon any consumer's premises, at all reasonable times, after giving one hour's notice of his intention to do so, enter any such premises and disconnect the consumer's wires from the service lines, and may require the consumer to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit. In any case where the undertakers require the services of an electric inspector under this regulation they shall pay him the prescribed fee.

(45) If on such testing, the officer or the electric inspector discovers that a connection exists between the consumer's wires and the earth, and that such connection has an electrical resistance not exceeding 5,000 ohms, or if the consumer does not give all due facilities for such inspection and testing, the undertakers shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of such discontinuance to the consumer, and shall not recommence such supply until they are reasonably satisfied that such connection with the earth has been removed. Provided that in cases where the maximum power taken by any consumer exceeds 25,000 watts, the consumer's wires may be divided for the purpose of this testing into separate circuits, the insulation resistance of each of which shall exceed 5,000 ohms.

(46) If any consumer is dissatisfied with the action of the undertakers either in discontinuing or in not recommencing the supply of energy to his premises, the wires and fittings of such consumer may, on his application, and on payment of the prescribed fee, be tested for the existence of connection with the earth by an electric inspector. This regulation shall be endorsed on every notice given under the provisions of the last preceding regulation.

VII.—*Arc Lighting.*

(47) All arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and shall not be used in situations where there is any danger of the presence of explosive dust or gas.

(48) Arc lamps used in any street shall be so fixed as not to be in any part at a less height than 10ft. from the ground.

(49) A cut-off switch, fixed in a suitable locked receptacle, shall be provided for every high-pressure arc lamp, and such switch shall be of such pattern and construction as will provide (*a*) that the lamp can by its means be entirely disconnected from the supply circuit; (*b*) that the switch itself can be safely operated in the dark by an inexperienced person and without special precautions; and (*c*) that there shall be no danger of any injurious electrical arcing, sparking, or heating being caused by the operation of the switch.

Penalties.—(50) If the undertakers make default in complying with any of the preceding regulations, they shall be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10. The imposition of any penalty under this regulation shall not affect the liability of the undertakers to make compensation in respect of any damage or injury which may be caused by reason of such default.

B.—Regulations as to Supply.

(1) One week at least before the undertakers are ready to commence to supply energy through any feeding, charging, or distributing main they shall serve a notice upon the local authority of their intention to commence such supply.

(2) From and after the time when the undertakers commence to supply energy through any distributing main they shall

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maintain a supply of sufficient power for the use of all the consumers for the time being entitled to be supplied from such main; and such supply shall, except so far as may be otherwise agreed upon from time to time between the local authority and the undertakers, be constantly maintained. Provided that, for the purposes of testing, the authority by whom the electric inspector is appointed may give permission to the undertakers to discontinue the supply at such intervals of time and for such periods as it may think expedient, and that for any other purposes connected with the efficient working of the undertaking, the undertakers may, with the permission of the Board of Trade, discontinue the supply at such intervals of time and for such periods as the Board of Trade may think expedient. Where the supply is so discontinued, notice of such discontinuance, and of the probable duration thereof, shall be forthwith served upon the local authority.

(3) The system of distributing mains shall be so arranged that in case it becomes necessary to stop the supply through any portion of a main for more than one hour, for the purposes of repairs, or for any other reason, the stoppage of supply will in no case exceed in amount a maximum power of 200,000 watts, or extend to the premises of more than 80 consumers, and in the case of every stoppage for more than one hour reasonable notice shall be previously given by the undertakers to every consumer affected thereby except in cases of emergency.

(4) During the whole of the period when a supply of energy is required to be maintained by the undertakers in the distributing mains under the order and these regulations, it shall be maintained at a constant pressure (in these regulations termed the "standard pressure") to be fixed as hereinafter specified; but such standard pressure may be different for different portions of the distributing mains. Provided that the undertakers shall be deemed to have complied with the requirements of this regulation so long as the pressure does not at any point vary more than 3 per cent. from the corresponding standard pressure in the case of a general supply at low pressure, or 2 per cent. in the case of a general supply at high pressure, unless changes in pressure recur so frequently as to cause unsteadiness in the supply.

(5) The standard pressure shall be fixed by the undertakers for every pair of distributing mains, and notice of the amount of such standard pressure shall be given to the local authority before the undertakers commence to supply energy to consumers through such mains, and such standard pressure shall not be altered except by permission of the local authority, and upon such terms and conditions as the local authority may impose, and after public notice has been given during a period of one month, in such manner as the local authority may require, of the intention of the undertakers to apply for permission to alter the same. The undertakers may appeal against any decision of the local authority under this regulation to the Board of Trade, whose decision shall be final.

(6) Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not, except by agreement, be greater than 150 volts or less than 45 volts if continuous, or the equivalents thereof respectively if alternating, and shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In distribution on the three-wire system, the central terminal shall for the purposes of this regulation be considered to form a pair with either of the outer terminals, and similarly for multiple-wire systems; and, in the case of a transformation of energy on the consumer's premises, the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be the declared constant pressure.

(7) The variation of pressure at any consumer's terminals shall not under any conditions of the supply which the consumer is entitled to receive, nor at any time, exceed 4 per cent. from the declared constant pressure, whether such variation be due to the resistance of the service lines or apparatus belonging to the undertakers, or to any action or effect produced by such apparatus, for which the consumer cannot be shown to be responsible, or, partly to any variation of pressure in the distributing mains from which the supply is taken.

(8) If the undertakers make default in complying with any of these regulations as to supply, they shall, subject to the provisions of the order, be liable to a penalty not exceeding £5 for every such default, and to a daily penalty not exceeding £5.

These regulations are made subject to the power of the Board of Trade to make such further or other regulations as they may think expedient, and nothing in these regulations shall be construed to authorise the undertakers to lay any electric line or work their undertaking otherwise than in accordance with the order and the principal Act, or to supply energy otherwise than by a system for the time being approved of by the Board of Trade under the order.

THE CITY AND WATERLOO RAILWAY.

On Tuesday evening a large party of members of the Institution of Junior Engineers paid a visit of inspection to the Waterloo and City railway works. A practical beginning of this undertaking was made about this time last year, and the company were able to traverse about half-a-mile of completed tunnelling. There are virtually two railways now lying down beneath the bed of the Thames near Blackfriars Bridge, each line being a quarter of a mile long at present. One, of course, is the "up" line, the other the "down." The two tunnels are not of the same size, and they do not take precisely the same course. The one of them running from Waterloo to the City is 12ft. 1½in. in diameter, the one in the opposite direction 12ft. 9in. The reason of this is that, as it has been said, the two lines take slightly different courses, and one has rather sharper curves than the other, and the carriages will require somewhat more space to curve round in. It would have been possible, of course, to make the tunnel slightly larger at the turning points, but it was deemed best upon the whole to make the enlargement throughout. The reason that the two lines do not run side by side all the way is that it is desirable to have a sharp gradient at the starting point and an easy one at the terminus of each line so that the levels of the two lines vary considerably, the difference of incline ranging from 1 in 800 to 1 in 60.

These and other details were explained to the visitors, says the *Daily News*, by Mr. Campbell, one of the assistants of the contractors, Messrs. Mowlem and Co., and the drawings were exhibited. The large company then proceeded in sections to descend to the works they had had described, the descent of about 70ft. being made by means of ladders fixed almost perpendicularly between three or four stages. When the works are going, the electric light is used throughout, operations being carried on during the whole 24 hours. Owing to the Whitsuntide holidays, however, the tunnels were in darkness when the first companies descended, and a singular-looking procession, with lamps and candles, burrowed its way along the gloomy galleries to the heading at the southern end, where an air-lock has been constructed, and preparations made for carrying on the work under air pressure, in anticipation of the tunnels emerging from the clay through which the whole of the river passage has been made, and penetrating a watery gravel. The visitors were warned beforehand that those of them who were conscious of any little weakness of heart, or who were suffering from a cold, had better not enter the air-lock, though the pressure at present was supposed to be only about 12lb. to the square inch above the normal. On reaching the lock, however, it was found that such little pressure as there had been had leaked away, and the company were able to inspect the arrangements without undergoing the pneumatic ordeal.

Thus far this undertaking has been carried on without any necessity for pneumatic pressure, the borings having been made through the sunken clay with 20ft. of it or so between the top of the tunnels and the bed of the river. Air-locks are, however, now about to be brought into operation at the headings on both sides of the river. At the southern extremity of the up-line tunnel the party, with their lamps and candles, halted for a time to get details of the working of the shield and the construction of the tunnel. The Greathead system of subterranean boring is now pretty generally understood in its main features. A circular shield with a cutting edge is driven by sheer hydraulic pushing through the soil, whatever it may be. But in front of this shield a "heading" is carried forward some feet in advance, this heading being excavated in the usual way by pickaxe and shovel. The centre of the tunnel being thus formed, the shield is driven forward and the full size of tunnel is cleanly sliced out. In this work the hydraulic force is applied by seven rams fixed at the back of the shield all round and operated on by hand pumps, the power applied being about 800lb. on the square inch. The cutting shield having been driven forward, the circular iron lining of the tunnel is fixed round in segments and belted together. In order to give a backing to this ironwork, and to fill up any irregularities of the surface of the soil behind it, grouting is poured in through small holes here and there. This soon sets as hard as solid rock. About 10ft. of tunnel can ordinarily be thus completed in the 24 hours. With this massive iron lining embedded in the grouting behind, the tunnel might be regarded as complete. In this case, however, the interior is concreted all round to the level of the ironwork flanges, this being done chiefly as a means of reducing the noise that has been found very unpleasant where the iron has been left uncovered.

The whole line when completed will be about a mile and a half in length. One terminus will be immediately beneath the South-Western Station at Waterloo. The other will be near the Mansion House, and will eventually have subterranean connection with the projected Central London Electric Railway, for which parliamentary powers have been obtained, and of

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which the public will probably hear more before very long. There will be no intermediate station between the City and Waterloo, though it seemed doubtful at one time whether one could not be constructed at Blackfriars. The trains will run from end to end without stopping, and as from each end they will start down a steep incline the journey will be performed in both directions very largely by the momentum thus acquired, supplemented, however, by electricity. The construction of the line is being carried on from a central point in the river marked by the conspicuous pile of staging within a short distance of Blackfriars Bridge, both tunnels being driven simultaneously in each direction. On one side of the river the course will be from a point in the river bank, a little to the east of Bull Stairs Alley, to the junction of Hatfield and Stamford streets, along Stamford-street to the corner of York-road and Waterloo-road, and thence to the terminus. In the other direction it will emerge from the river at the north-west corner of Blackfriars Bridge, and will pass up beneath the middle of Queen Victoria-street, having above it at one point a main sewer, and the District Railway above that. The terminus at the City end will be 63ft. below the roadway, while at the other the station will be 35ft. below the South-Western platforms. Waterloo being built upon arches renders it comparatively easy to bring in this new line beneath it. The estimated cost of the new line is half a million of money, and it should be completed in about 18 months from the present time. The work thus far appears to have gone on very smoothly and rapidly, and though the most troublesome part of the business is probably about to be entered on, there is no reason to apprehend any great difficulty in rapidly and successfully carrying it through. Great interest was evinced in all the engineering details of the work, and votes of thanks were accorded to Messrs. Mowlem for permitting the inspection, and to Mr. Campbell for generously sacrificing a portion of his brief holiday to the task of conducting this large party over the works.

LEGAL INTELLIGENCE.

MARSHALL v. SOUTH STAFFORDSHIRE AND BIRMINGHAM TRAMWAY COMPANY.

In the Appeal Court on Thursday last week, before the Master of the Rolls and Lords Justices Smith and Rigby, the appeal of the defendants in the case Marshall *v.* South Staffordshire and Birmingham Tramway Company was heard.

The plaintiff, Mr. Gerald Cook Rodgers Marshall (Chelmsford), brought an action to recover £400 principal and £50 interest upon his mortgage debentures in the defendant company, which is registered at Darlaston. Baron Pollock allowed the plaintiff to sign final judgment under order 14, and the defendants appealed for leave to defend on the ground that they had an absolute defence to the action both as regarded the principal and as regarded the interest.

Mr. Murphy, Q.C., who appeared in support of the company's appeal, said that the defence was that the principal was not due until August, 1893, and the interest still later. Mr. Willis Bund appeared for the respondent.

The **Master of the Rolls** said it was not a case for order 14, and the plaintiff was not entitled to sign the final judgment. The order of Baron Pollock was not a peremptory one, and the appeal would be allowed, with costs in that Court and in the Court below.

The other Lords Justices concurred.

The case will now come on for trial in the ordinary way.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Braila.—Tenders are invited by the municipal authorities of Braila, Roumania, by June 17 (29), for lighting the town by gas and electricity. Security required, 25,000f.

Grimsby.—Tenders are invited for the lighting of the public streets for one year, for the Urban Sanitary Authority. We have already given particulars. Tenders are to be delivered by 5 p.m. to-day (Friday.)

Edinburgh.—The Town Council invite tenders for painting the street electric lamp-posts. Specifications are obtainable from the resident electrical engineer, 5, Dewar-place, Edinburgh. Tenders are to be sent in by 10th inst.

Paris.—Tenders are invited for electric lighting plant for the Boucicaut Hospital by the Bureau des Travaux de l'Assistance Publique, 3, Avenue Victoria, Paris, the estimated cost being 68,000f., or, say, £2,720, and for electric light fittings, the estimated cost being 40,000f., or, say, £1,600.

St. Pancras.—Tenders are invited for the supply of Welsh steam coal, suitable for electric works (colliery and seam to be stated), for 12 months from July 1, 1895, delivery to be made as required, average about 60 tons per week, for the Vestry of St. Pancras. Tenders to be sent to Mr. Albert E. Pycraft, chief clerk, electricity and public lighting department, Vestry Hall, Pancras-road, endorsed "Tender for Coal," by 12 noon on 13th inst.

London, E.C.—Tenders are invited by the G.P.O. for the purchase of about 35 tons of old copper (wire, plates, etc.), a large quantity of other metals (brass, zinc, iron, and steel), india-rubber-covered wire, mercury deposit, indiarubber, tinfoil, felt, rope, tar barrels, raw hide pieces, etc. A form of tender can be obtained from Mr. Charles E Stuart, controller of stores, G P.O., Telegraph-street, E C. Tenders will be received until Monday, June 17.

Madrid.—The Spanish Postal and Telegraphic Administration invites tenders by June 28 for the supply of 20 tons of copper. Preliminary security 5 per cent., definitive security 10 per cent., maximum price 520 pesetas per ton. Conditions, etc., and forms of tender from La Direccion General de Correos y Telégrafos, Madrid.—Tenders are invited up to June 10, 1895, by La Direccion General de Obras Publicas, Madrid, for the construction and working of a tramway from Murcia to Alcantarilla and Espinardo. Security, 3,498 pesetas.

York.—Tenders are invited for the following articles during six months ending December 31, 1895 delivered carriage paid at the stores at York, for the North-Eastern Railway Company: (1) telegraph apparatus; (2) telegraph wire and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash, less 2½ per cent discount. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent to Mr. C. N. Wilkinson, secretary, York, sealed, and marked "Tender for Telegraph Stores," by noon on June 10.

London.—The Secretary of State for War gives notice that purchases for specific quantities of various articles will be made from time to time during the current year. Among them are electrical instruments for submarine mining and telegraph cable and wire. Manufacturers who may be desirous of tendering should apply to Mr. G. Lawson, director of army contracts, War Office, Pall-mall, S W., by letter, giving at least names of two well-known firms or public bodies who have purchased from them and are in a position to certify as to the quality of their productions. Applications unaccompanied by references will not be noticed. Firms whose names are already on the War Office list need not apply, as forms for tendering will be sent to them in due course.

St. Helens.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of the following plant: Section A—boiler-house plant, including boilers and fittings, forced draught apparatus, feed pumps, etc.; Section B—engine-house plant, including steam alternators, oil-filter, fittings, etc., steam, exhaust, feed, blow-off, and sundry pipes, valves, and water-tanks, etc.; Section C—main switch-board and instruments; Section D—underground work, including cables, junction-boxes, culverts, and trenching; Section E—transformers and fittings; Section F—meters; Section G—overhead crane. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. The ground plan of plant, plan of streets, etc., and specification, with terms and conditions of tender and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on and after June 11, on payment of £2 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed, and marked "Tender for Electric Lighting," must be addressed to the town clerk at the Town Hall, St. Helens, and be delivered on or before Tuesday, July 2.

RESULTS OF TENDERS.

Chester. - The City Council have accepted the tender of Messrs. Parker and Co., Wolverhampton, for carrying out an installation of the electric light as the illuminant for the public streets.

Cheltenham.—The Corporation have received the following tenders for the wiring of the library for electric light: Messrs. R. E. and C. Marshall, £105. 10s. 6d. (accepted); Mr. A. G. Sanders, £118. 9s.

Burton-on-Trent.—The Town Council have accepted tenders for the supply of coal from the Sheffield Coal Company, the Staveley Coal and Iron Company, and Messrs. J. and G. Wells for the electric light station, and the tender of the Telegraph Manufacturing Company, of Helsby, near Warrington, for the supply of high and low pressure cables for the extension of the electric light into the outlying parts of the town. The tender of the Stanton Ironworks Company for cast-iron pipes has also been accepted.

Change of Partnership.—Notice is given that the partnership lately subsisting between James Aram Lea, Francis James Lea, and Arthur Henry Lea, carrying on business as electrical and general engineers and art and general metal workers at Pengwerne Works, Chester-street and The Square, Shrewsbury, under the style of Lea, Sons, and Co., has been dissolved by mutual consent, so far as regards Arthur Henry Lea, the junior partner of the said firm, who retires therefrom. All debts due to or owing by the said late firm will be received and paid by James Aram Lea and Francis James Lea, the senior partners thereof, who will continue the business under the style of Lea, Son, and Co.

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BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,659.

Bridlington.—It is stated that the Urban District Council have made the last payment towards the electric light plant.

Siemens and Halske.—It is reported that the Vienna firm of Siemens and Halske is about to be converted into a joint-stock company.

Direct Spanish Telegraph Company.—For the month of May the receipts were £2,017, as against £1,594 for the same period of 1894.

Eastern Telegraph Company.—The receipts for the month of May were £68,382, as against £54,846 for the corresponding period of 1894.

Hobart Electric Tramway Company, Limited.—The annual general meeting will be held on 11th inst. at the London offices, College-hill, E.C.

Nottingham.—Additions are being made to the Nottingham Station of the Midland Railway Company, and an electric lighting plant is to be laid down.

Eastern Extension Telegraph Company.—For the month of May the receipts show an increase of £660 as compared with the corresponding period of 1894.

Aberdeen.—The Town Council have received a communication from the Board of Trade as to proposed amendment of regulations, and this has been remitted to the Gas Committee.

Bell's Asbestos Company, Limited.—The directors of this Company have elected as a member of the Board Mr. W. Claude Johnson, M.I.C.E., of the firm of Messrs. Johnson and Phillips.

New Departure in Arc Lighting.—Messrs. Drake and Gorham inform us that they will in a few weeks' time put on the market the Jandus arc lamp, which will burn for 200 hours with one pair of carbons.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 26th ult. amounted to £1,146, as compared with £830 in the corresponding week of last year, being an increase of £316.

Portsmouth.—Arrangements for the installation of the electric light at St. Agatha's Church, Landport, have been entered into by the Town Council. The current will be supplied to both the old and new church buildings.

West Cowes.—Mr. Nelson Dennis, the surveyor to the West Cowes Urban District Council, has drawn up a scheme for the electric lighting of the town. Mr. Francis H. Medhurst has been called in to report on the same.

Kendal.—The Town Clerk informed the Town Council that the Board of Trade had communicated to the parliamentary agents that the Windermere Electricity Company had withdrawn the application to include Kendal in the provisional order.

Dublin.—On Friday last a meeting of the members of the Dublin Mercantile Association, who are subscribers to the telephone exchange, was held for the purpose of drawing attention to various grievances connected with the present telephone system.

Ayr.—The Town Council have resolved to introduce the electric light into the Municipal Buildings, and to get the Police Commissioners and one of the Corporation's tenants to pay 5 per cent. on the internal fittings, in addition to holding them liable for the upkeep of the internal fittings.

Agency.—Messrs. Francis and Spilsbury, electrical agents and suppliers, of Mansion House-chambers, 20, Bucklersbury, London, E.C., have taken up an agency for Messrs. A. P. Lundberg, Bradbury Electrical Works, Kingsland, and are now in a position to supply their manufactures from stock.

Val D'Aosta Electric Power Company, Limited.—This Company has been registered, with a capital of £80,000, to acquire, take up, and hold concessions for the utilisation of water, etc., in any part of the world, and to carry on the business of an electric light and power company in all its branches.

City and South London Railway.—The returns for the week ended June 2 were £929, compared with £869 for the corresponding period of 1894, being an increase of £60. The total receipts for the current period of the present half-year are £20,533 against £20,013 in the corresponding period of 1894, an increase of £520.

Large Hungarian Electrical Company.—Some stir has been created in Austrian and German electrical circles by the announcement that the Hungarian Kreditbank, in conjunction with the firm of Ludwig Loewe and Co., purposes founding a new general electric and finance company in Budapest, with a capital of 5,000,000fl., or £500,000.

Fulham.—The Vestry have instructed the clerk to invite not more than three electrical engineers of good standing, to be named by the committee, to state their fees for a complete report on, and full estimate of expenditure for, the installation and maintenance of the electric light for the parish of Fulham in conjunction with a dust destructor.

Coventry.—A meeting of the Town Council has been held, at which Mr. West moved the adoption of a report from the Electric Lighting Committee embodying detailed instructions for the management of the electric light undertaking on a commercial basis, which was adopted with the addition of a clause providing for a financial return to be submitted annually.

Ootacamund (India).—The Oriental Electric Light Company, of London and Bombay, having decided to establish a branch business in Ootacamund, the company's agent, Mr. A. B. Simpson, has arrived there and is prepared to furnish estimates for lighting the principal residences, clubs, hotels, etc., on the maintenance electric supply system by storage on the hire system.

Rickmansworth.—A meeting of the Parish Council has been held, at which Mr. Dockree said he found from an electrician that they had enough water power at Batchwood Bridge to supply Rickmansworth with electric light at £500 less than it cost to supply the town with gas. At the present time gas cost £2,000 a year, and they could furnish the town with electric light for £1,500.

Kensington.—The Fire Brigade Committee of the Kensington Board of Guardians has recommended that no action be taken upon the London County Council's letter on the subject of telephonic communication with the nearest fire station, it being pointed out that the expense would be hardly justified, seeing that the present alarm post was so close to the house. The committee's report was adopted by the Board.

Protection from Fire.—We are informed that the Chelsea Electricity Supply Company have just had a number of Merryweather's improved hydrants and hose, etc., fitted up at their Draycott-place station, and that this firm has carried out similar work for the Brush Electric Light Company, the Metropolitan Electric Supply Corporation, the Edison and Swan, and several other important companies.

Large German Undertaking.—A short time ago several prominent banking firms, in conjunction with the Elektricitäts-Gesellschaft vormals Schuckert and Co., founded a joint-stock concern entitled the Kontinentale Gesellschaft für Elektrische Unternehmungen (Continental Company for Electrical Enterprises) with a capital of 16,000,000 marks, or £800,000. It is stated that 7,000,000 marks, or £350,000, of this amount has already been paid up.

Tonbridge.—Mount Pleasant Congregational Church has been reopened after alterations and repairs. This is the first church in the town in which electric light fittings are to be seen. The fittings for the electric light have been installed by Messrs. Verity and Sons. The pulpit is furnished with two combination standards for both gas and electricity, and these are so arranged that at any moment the minister can turn on the gas or electricity, or both, at the same time.

Electric Lighting of the Houses of Parliament.—In the discussion on supply in the House of Commons the other evening, Mr Weir expressed the opinion that the electric light ought to be universally adopted in the Houses of Parliament, but Mr. A. C. Morton thought it would be unwise to spend too much upon additional electric light. Mr. Herbert Gladstone, in reply, said he thought on the whole that the House should be provided with current by an independent company.

Appointment Vacant.—There is required, as assistant gas and electricity manager, by a gas company in West Australia, a young married man, who is thoroughly and practically acquainted with gas manufacture and gasworks construction and management; also capable of taking charge of electric lighting plant. Wages £250 per annum, with house, light, and fuel. State age, family, general qualifications, etc, and give references or copies of recent testimonials, to Box 61, P. O., Oldham.

Belfast.—A meeting of the Electric Light Committee of the Corporation has been held, when the engineer (Mr. M'Cowen) submitted applications from the Belfast and Northern Counties Railway Company and the Ulster Hall Company for the supply of current, both of which would necessitate the extension of the present system of mains, and he was instructed to enquire as to the probable consumption and the prospects for further demands for lighting in those districts, and report at next meeting.

Wandsworth.—A meeting of the District Board has been held, at which permission was granted the County of London and Brush Provincial Electric Lighting Company to lay their mains in the Board's district; but the Board disapproved of the construction of the proposed converting stations or transformer-chambers, and the electric lighting company are to be informed that the Board are of opinion that the required stations or chambers should be constructed on land not forming part of the public way.

Hammersmith.—The Electric Lighting Committee of the Vestry having viewed installations at Chelsea, Ealing, St. Pancras, and Portsmouth, have advised the Vestry that they could not recommend them to adopt the report of Messrs. Williams and King. The Vestry have, however, decided to advertise for complete schemes and tenders for boilers, machinery, mains, etc., necessary to carry out the work included in the compulsory area. When these are received the Vestry will proceed to consult one or more engineers to advise on the subject.

Chelmsford.—The Lighting Committee of the Town Council at the last meeting of that body recommended that the Board of Trade electric lighting order be transferred from Crompton and Co., Limited, to the Chelmsford Electric Lighting Company, Limited. Alderman Duffield asked a question as to the security, whereupon Councillor Britton, the chairman of the Lighting Committee, rose to say he thought this matter might be allowed to go through without further discussion. It had been on for two years, and ought now to drop. The recommendation of the committee was adopted after some discussion.

Douglas (Isle of Man).—The Douglas Town Commissioners, at a specially convened meeting on Friday afternoon, had under con-

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sideration an important offer from the Douglas Bay Tramway Company. The company agreed, in return for the concession of being permitted to lay a double line along the front of Douglas Bay, and of an extension of the present lease, which terminates in three years, for 21 years, to pay the Commissioners £1,500 a year and construct and work a tramway to Upper Douglas. The latter undertaking is calculated to result in a loss to the company of £1,000 a year for some years to come, but it is expected that the extension of the lease of the Douglas Bay tramway will more than make up for the loss. The debate was adjourned.

Dover.—A meeting of the Town Council has been held, at which the report of the proposed Board of Trade regulations in reference to the electric light which had been referred to Mr. Slingo for consideration was received Mr. Slingo stated that they were generally satisfactory, but it was desirable that the ventilation, etc , of street boxes should be more efficient to prevent accumulation of gas. He also suggested that an independent and careful examination of the mains and works should be made. Councillor Ayers, seconded by Councillor Clark, moved that no action should be taken, but on the motion of Alderman Adcock, seconded by Alderman Pepper, it was decided to refer the matter to the Electric Light Committee to report on, and if it were necessary to appoint an inspector.

Dundee.—At the beginning of the year it was estimated that the expenditure in the electricity department of the Town Council would amount to £5,362. 6s. 7d., whereas the actual expenditure was £5,874. 16s. 7d., a difference of £512. 10s. The income from electricity was estimated at £3 200; meter rents, £120—a total of £3,320, the actual income being £3,525 10s. 9d., and £168. 2s 11d., altogether £3,693. 13s. 8d., showing an increase on the estimate of £373. 13s. 8d. The electricity department accounts for last year were balanced by drawing £2,181. 2s. 11d. from the gas department. For the current year the income estimates are—for electricity £4,200, and for meter rents, £200, being a total of £4,400. The expenditure is expected to be £4 386. 14s. 4d , and it is therefore estimated that for the year ending April 30 next there will be a surplus of £13. 5s. 8d.

Fifeshire.—At a meeting of the Telephone Committee of Fife County Council on Tuesday Mr. William Patrick, clerk, intimated that the National Telephone Company had again refused to give the rent asked and the free use of instruments for the privilege of wayleave. Mr. Hugo Haig, the chairman, moved that the Council notify to Lord Balfour, the chairman, that unless the company give the terms that are asked by the Fife County Council the wires will be cut throughout the county within six days. This was unanimously agreed to, and the telephone company are to be notified accordingly. It is 18 months since the negotiations commenced, and the committee are exasperated at the delay. If the telephone company be successful in delaying a settlement for another month the telephone system will by that time be taken over by the Government, and Fife County Council might not then get any equivalent for wayleave.

Darlington.—The Board of Guardians have held a meeting at which the Workhouse Committee recommended that the telephone should be continued to the infirmary, so as to enable the night nurse to communicate direct with the doctor. This was agreed to. Mr. Bartlett suggested that the clerk's office should be put on the National Telephone system. He thought this would be a distinct advantage, as just recently he was prevented from communicating with the clerk in time to have some of the unemployed of the town put into positions in connection with the County Council. He moved that the matter be referred to the Workhouse Committee for consideration. The Workhouse Committee reported that Messrs. Cox-Walker had offered to connect the workhouse with the police office for £20. 4s. 6d. This was considered necessary for the purpose of raising an alarm in case of fire. The matter was referred back to the committee for consideration.

Surbiton.—The annual general meeting of the shareholders of the Assembly Rooms Company has been held, at which Mr. Coochey urged that as the mains passed within a few feet of the rooms the directors should have the electric light laid on. The Chairman said he was so much impressed with the desirability of having the electric light that he asked their manager to make enquiries, and he was at once met with the statement that the Corporation could not supply it beyond the borough boundary, and that the Surbiton Commissioners would not agree to their doing so. Mr. Harrison confirmed this, but Mr. Knapp said he was told that the Corporation had power to supply beyond their own area with the consent of the District Council. Mr. Moatt said the matter had never been before the Surbiton Council yet. The Chairman promised that the directors would consider the question, and he hoped to be able to give a favourable reply next year.

Brighton.—The Lighting Committee of the Brighton Town Council report that they have advertised for and received tenders for the supply of pillars, etc., for the electric light arc lamps proposed to be erected in certain streets of the borough. The tenders received for the 80 cast-iron and drawn-steel bracket posts for suspending electric light arc lamps are as follow: Pierson and Co., 124, Fenchurch-street, London. £3,680; Newton, Chambers, and Co, Limited, Sheffield, £2,640; Hart. Son, Peard, and Co., Limited, Birmingham, £2,600. Informal tenders for these posts were also received from Messrs. Macfarlane and Co., Messrs. Reed and Son, Messrs. G. Smith and Co, Messrs. Mackenzie Bros., Messrs. Baird, Son, Thompson, and Co., and the Alloa Iron Company. The committee recommend that the tender of Messrs. Hart, Son, Peard, and Co. be accepted. It was found that the tenders received by the committee for the supply of the 45 cast-iron upright posts, with bracketed canopies, required for supporting electric light arc lamps, need further consideration, and the committee have deferred their report until the meeting of the Council on 20th inst.

West Coast of America Telegraph Company.—The report of the directors for the year ended December 31 last states that the gross income for the year 1894 was £21,753, as against £15,096 in 1893, and in order to provide for the payment of the debenture coupons, it was necessary this year to take £10 400 from the reserve The sterling value of the local traffic for 1894 was again most seriously affected by the low rates of exchange, both in Peru and Chili, the value of the dollar in Chili having fallen as low as 10⅜d., and the average rate for the year was 12d., as against 14d. in 1893. In view of the recent legislation in Chili, by which the paper currency of the Republic is to be replaced from June 1 by gold, on the basis of 18d. to the dollar, it may fairly be hoped that exchange in the future will not greatly fluctuate from that figure. It may also be anticipated that the use of the telegraph for commercial purposes will continue to increase. The total expenses were £20 154, against £19,632 in 1893. The Company's cables and land lines, as well as the repairing steamer "Retriever," continue to be maintained in a state of efficiency, consistently with which every possible economy is practised with regard to the expenditure. The direct service between the Company's stations and Europe, *vid* Madeira, appears to have afforded every satisfaction to the public.

Cheltenham.—Mr. A G. Sanders, electrical engineer, Clarence-parade, has explained to the Electric Lighting Committee of the Town Council that several installations carried out by him in the town had not yet been connected with the mains, though most of them had been carried out some months back, and applications sent in. The Town Council resolved that the town clerk should write and thank him for drawing attention to the cases mentioned by him, which were receiving attention, and would be connected as soon as possible. Several extensions of the mains are projected, including a main from the works to the top of Bayshill, at an estimated cost of £1,300, extending along the Arle-road, Gloucester-road, and St. George's-road to the railway bridge there to branch in two directions—one to St. George's-parade, and the other up the Western-road, part of Christ Church-road, and along Lansdown-terrace. A letter from Messrs. David Midgley and Sons of 48, Princess-street, Manchester, was read by the Finance Committee, offering to lend to the Corporation a sum of £2 000 at 3 per cent, for a fixed term of five, seven, or ten years. It was resolved to accept Messrs. Midgley and Sons' offer on account of the electric loan for a term of 10 years, determinable by either party at the end of the fifth or seventh year by six months' notice in writing.

Islington.—The Vestry have held a meeting, at which a report was received from the Electric Lighting Committee, stating that in the erection of the central station it has been found urgently necessary to utilise a portion of the gardens of 19, 21, and 23, Burnard-place to enable the erection to proceed on that side of the site; and having regard to the nearness of such houses to the station, and to the fact that some cause of action against the Vestry may accrue in future by virtue of possible nuisances to the occupiers arising from the running of the machinery and other matters, and further, that as the sites of the houses will shortly be required for the purpose of extension it recommends that the offer of the tenant for life, his trustees and reversioners, to join and assign to the Vestry the outstanding leases of the above houses (the freehold of which the Vestry has already acquired subject to such outstanding leases), and to give vacant possession for the sum of £350 per house and vendors' solicitor's costs according to scale be accepted, subject to a good title being shown, and to one solicitor only being employed to represent the whole of the vendors. Mr. Lambert, in moving the adoption of the report, said they had purchased all the houses with the exception of No. 1. He considered that the purchase was a good bargain They had already purchased the freehold, and they now wished to acquire the leasehold for £350 per house. Mr. Goodman, in seconding, said the opinion of some of them was that in the market the houses would not be worth that money; but if he had not been a vestryman, he would have been glad of the opportunity of acquiring the leaseholds at the price it was proposed to pay for them. He hoped the Vestry would not lose the chance After some discussion, the motion was agreed to.

Tunbridge Wells.—The lady of the manor has agreed to allow the Pantiles to be included in the new electric light scheme. The engineer (Mr. Preece) has laid before the Lighting Committee of the Town Council estimates of the cost of constructing new transformer stations, and extending the mains along Mount Ephraim (from Mount Ephraim-road to the Grosvenor Fountain), in Monson-road, and in Calverley-road (from Camden-road to Mr. Howard's corner) amounting to £630. 10s. It was resolved that these extensions be approved, and that Mr. Preece be authorised to proceed with them at once. The question of the arrangements to be made for plans, showing how it is proposed to expend the £12,000 recently sanctioned by the Council for extensions, was discussed with Mr. Preece. It was resolved that Mr. Preece be engaged to prepare all plans and estimates, and to do all work required from the electrical engineer up to the obtaining of the sanction of the Local Government Board to the additional loan, including attendance at the public enquiry, and that he be paid for these services 2½ per cent. upon the amount of his estimate, it being understood that the total additional amount to be borrowed does not exceed £12,000, and also that in the event of the Council desiring Mr. Preece to undertake the superintendence of the carrying out of the works covered by the new loan

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he will give the same services as he has done in respect of the present works for an additional 2½ per cent. on the amount expended. Councillor Wood intimated to the Town Council that private applications for the electric light were coming in rapidly from all parts of the town. The Mayor said doubtless before the winter season many residents would ask for the light. In reply to questions, Councillor Wood said the works were nearly complete, and the chief lamps had been fixed for use.

Luton.—A meeting of the Town Council has been held, at which the clerk informed the Council that the Mayor, Mr. Giddings, and himself had had an interview with the parliamentary agents in reference to the notice that had been lodged by the Luton Gas Company concerning the electric lighting order, and the understanding arrived at was that if the opposition or the application was not withdrawn the Corporation intended to go on with the matter, and they would be prepared to be examined by the Select Committee. Subsequently, he (the clerk) saw Mr. Phillips, the manager of the gas company, who stated that possibly the Corporation had misunderstood the purport of the notice. It was impossible for the company to appear before the committee unless they had given notice of opposition to the various clauses to which they took objection, and therefore they were compelled to give that notice in order to qualify themselves in that respect. He had explained to Mr. Phillips that he thought possibly he was not aware that the Board of Trade were preparing new regulations, based to a great extent upon the report made by Major Cardew on the explosions that took place in London, and, after a general conversation, Mr. Phillips wired his parliamentary agents requesting them to seek an interview at once with the agents of the Corporation. The result was that a telegram came to say that the opposition had been withdrawn, and therefore there was no occasion to appear before the committee. He thought it was due to Mr. Phillips that this explanation should be made. It was expected that the matter would be completed about the middle of this month. The Mayor thought the Council would agree with him that this was a very satisfactory conclusion of the matter. He thought the town clerk was to be commended for the tact and judgment which he had exercised, and which had saved what would probably have been considerable expense.

Consolidated Telephone Construction and Maintenance Company.—The directors, in their report for the year ended March 31st last, state that the operations for the past year show a manufacturing profit of £1,403. The amount available for disposal, after the usual provision for doubtful debts, etc., is £2,866, from which the directors propose to pay a dividend of £1. 10s. per cent., leaving a balance of £1,236 to carry forward. The competition (principally foreign) in the manufacturing business has continued with unabated severity, the selling prices of all articles having been largely reduced. The lease of the present factory terminates at Christmas next, and it is proposed, if suitable premises can be found, to remove the plant, machinery, etc., to the country, with the object of reducing the expenses of production, in the shape of labour, rent, and the heavy rates now being paid. Various manufacturing proposals have been submitted to the directors, one of which, for the manufacture of a unique form of battery and accessories, has been adopted, the Company having obtained the sole right to manufacture all supplies required by the patentees of the capsule battery for the whole period of the patent—viz, 14 years. It is proposed to alter the memorandum of association to enable the Company to manufacture other articles than those solely electrical, and a resolution will be submitted to that effect at the extraordinary general meeting. The directors are hopeful that this extension of business will be advantageous to the Company. The lawsuit in Belgium, undertaken, in conjunction with the Edison Gower-Bell Telephone Company, against infringers of the patent held by the Company, resulted in a successful appeal against the previous decision, and the Court has ordered a claim to be sent in for damages. The subsidiary company, the Anglo-Portuguese Telephone Company, continues to show satisfactory progress.

Medical Electrical Institute, Limited.—From the observations of the senior official receiver (Mr. C. J. Stewart), issued under a winding-up order recently made in this case, it appears that the company was registered on October 16, 1894, and was formed for the purpose of acquiring the business hitherto carried on by the Medical Battery Company, Limited, for the sale of medical and electrical appliances, etc. An order of Court had been made on November 22, 1893, for the winding up of the old company. Meetings were subsequently held of the creditors and shareholders of that company, which unanimously approved of a scheme of reconstruction, and on July 25, 1894, the Court sanctioned the scheme, of which the Medical Electrical Institute is the outcome. The registered capital of the new company was £75,000, of which £50,000 ordinary shares were to be issued as fully paid to the shareholders of the old company, while £25,000 preference shares, or such portion of them as might be required, were to be issued to the unsecured creditors of the old company in accordance with the admission of the proof of such creditors by the official receiver. On October 17, 1894, Mr. C. B. Harness, who had previously been the managing director of the old company, was appointed manager of the new company at a salary of £600 a year. It subsequently became apparent that the new company was not in a position to carry out the terms of the scheme of reconstruction, and in January last Mr. Ernest Hart was appointed by the Court receiver for debenture-holders and is understood to have been since that date in possession of all the company's assets. Upon the commencement of business by the new company, advertisements seem to have been inserted in various newspapers upon a considerable scale in the hope that as a result the demand by the public for the medical and electrical appliances sold by the company would greatly increase it appearing that the former prosperity of the old company was in a large measure due to a system of extensive advertising. In this hope, however, the Board were disappointed, and the secretary states that the advertisements did not produce sufficient business to pay expenses. The official receiver observes that it will be seen from the accounts that, after paying the costs of liquidation, the margin of cash left for working capital was only about £1,000 The statement of affairs shows liabilities £11,614, of which £5,472 are unsecured, with net assets nil. The failure of the company is attributed to loss on the trading and to the want of funds to carry on the advertising for such a length of time as might possibly have rehabilitated the business

Elmore's German and Austro-Hungarian Metal Company.—The directors, in their report to December 31 last, state that the accounts call for little remark, as the figures have changed but little from those of 1893. The second debentures have been reduced from £49,480 to £25,980 by redemption. The terms of the redemption were very favourable to the Company, and the great reduction of the capital was carried out at a cost of only £11,750, and this in preference shares. The amount advanced to the Metal Company by this Company is now £15,947. As security for the amount, this Company holds two mortgages upon the property amounting together to £15,000 which are a first charge, subject only to the payment of the balance of the final instalment of the purchase-money. With regard to the Metal Company's accounts, these also call for but little remark, the principal alterations in the figures being the additions and improvements to buildings, machinery, and plant, the increase in materials and stores in hand, and the increase of amount due from sundry debtors. The amount due to sundry creditors is somewhat large, owing to the amounts payable to contractors on account of the new plant. The directors regret that the amount standing to the debit of profit and loss account (£19,909) has increased. This is to a considerable extent caused by the heavy depreciation account, which has been deducted as heretofore. The directors are glad to report that although the new plant was not completed until the end of 1894 the sales had increased from £3,194 in 1893 to £8,130 in 1894, and that the loss on factory account was practically nil. It must be borne in mind that the working of the company was greatly restricted by want of funds during the early part of the year. With regard to the general work of the factory to date, the directors are able to report satisfactory progress. The new plant has proved to be of great value, and is a marked improvement upon the plant originally erected. The rate of progress has not been so rapid as the directors could have wished, delays having occurred owing to the severe frost, an accident to the drawbench, and other causes, which have seriously retarded work. Notwithstanding all this, however, the sales are over three times as great as for the same period last year, and the directors see no reason why the rate should not now increase to a much greater extent. The number of customers increase weekly; indeed, the directors find the question of orders the least difficult to deal with, as, although they do not advertise and have no travellers, they are in receipt of an abundance of good paying orders. They are also able to report that the Company has entered into further contracts for the supply of copper tubes, including one with the Imperial State Railways. The directors propose later to still further increase the number of tanks in the factory This can be done at a nominal cost, and will greatly increase the earning capacity of the factory.

PROVISIONAL PATENTS, 1895.

MAY 27.

10334. **An improved arrangement of electric call or sounding apparatus.** William Arthur Price, 6, Bream's-buildings, Chancery-lane, London.

10359. **Improvements in carriers for shades and like objects for gas and electric light fittings and the like.** Edward William Lancaster, Albert Works, Graham-street, Birmingham.

10360. **Improvements in tumbler switches for electric circuits.** Edward William Lancaster, Albert Works, Graham-street, Birmingham.

10366. **A new or improved electrical stage effect and appliances therefor.** David Alexander and Claud Hamilton, Limited, 70, Wellington-street, Glasgow.

10418. **Improvements in or connected with time-recording apparatus for consumption of electric current.** Robert Wende, 27, Karlstrasse, Berlin.

10433. **Improvements in dynamo-electric generators and motors.** George Edensor Dorman, The Hawthorns, Newport-road, Stafford.

10445. **Improvements in apparatus for electrolysis of alkali salts with quicksilver as cathode.** Henrik Christian Fredrik Störmer, 77, Chancery-lane, London. (Complete specification) (Date applied for under Patents, etc., Act, 1883, Sec. 103, November 26, 1894, being date of application in Norway.)

10480. **Improvements in methods of supplying electricity to arc lamps.** Arthur Wright, 26, Park-crescent, Brighton,

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10448. **Improvements in secondary or storage batteries.** Lius Falero and Henry Lumley, 24, Southampton-buildings, Chancery-lane, London.

MAY 28.

10502. **Improvements in movable pendants and brackets for suspending and carrying electric, gas, or oil fittings and for other purposes.** Edward William Lancaster, Albert Works, Graham-street, Birmingham.

10518. **A self-contained electrical grinding machine.** Cecil Fane, 98, Leadenhall-street, London.

10535. **An automatic device for use with electric motors.** Cecil Burman Callow and Henry Justus Eck, 13, Burnaby-gardens, Chiswick, London.

10536. **An automatic device for starting electric motors.** Cecil Burman Callow and Henry Justus Eck, 13, Burnaby-gardens, Chiswick, London.

10538. **Improvements in dynamo-electric generators and motors.** George Edensor Dorman, The Hawthorns, Newport-road, Stafford.

10539. **Improvements in dynamo-electric generators and motors.** George Edensor Dorman, The Hawthorns, Newport-road, Stafford.

10569. **Improvements in electrical apparatus for lighting gas.** Eugene Massy, 65, Chancery-lane, London.

10587. **Improvements in and relating to electric heaters.** Charles John Reed, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 29.

10604. **Improvements in insulators or insulated connections for telegraph, telephone, and other electrical wires.** Richard Taylor, 24, Temple-row, Birmingham.

10614. **Improvements in or relating to electric telephone systems.** Thomas Sloper and George Edmund Beckett, 14, Brittox, Devizes.

10647. **Improvements in the electrical propulsion of boats and vessels.** Anthony George New and Arthur James Mayne, 55, Chancery-lane, London.

10655. **Improvements in and connected with arc electric lamps.** Gustav Binswanger and Arthur Ernest Angold, 73, St. Stephen's-road, Upton Park, London.

10656. **Improvements in and connected with arc electric lamps.** Gustav Binswanger and Arthur Ernest Angold, 73, St. Stephen's-road, Upton Park, London.

10660. **Improvements in or relating to electric contact makers.** John Dudley Stuart, 4, Guildford-crescent, Cardiff.

10672. **Improvements in apparatus for measuring or indicating the frequency of alternating or pulsating electric currents or potential differences.** Albert Campbell, 34, St. George's-square, Regent's Park, London.

10679. **Improvments in or connected with furnaces or apparatus in which materials are fused by means of an electric arc.** Donald Barns Morison, 46, Lincoln's-inn-fields, London.

MAY 30.

10685. **Improvements in electrical thermometers.** George Chandler Whipple and Henry Ellis Warren, 55, Chancery-lane, London. (Complete specification.)

10687. **Improvements in the arc striking and feeding devices and arc lamp frames, more especially applicable to those arc lamps used singly or two or more in series across incandescent or constant-potential mains** Frederick D'Artrey Goold, South-Western Hotel, Woking, Surrey.

10746. **Improvements in or relating to the connecting and disconnecting the sockets of incandescent electric lamps.** Percy Benham and Walter Smith, 323, High Holborn, London.

MAY 31.

10778. **Improvements in dynamos and motors.** John Perry, 31, Brunswick-square, London.

10779. **A new method of and apparatus for the conversion of heat energy into mechanical energy and into electrical energy.** Frederick Hamer, 266, Camberwell New-road, London.

10792. **An improved dry battery for electrical purposes and material for packing same.** William Elliott, 75, Philip-lane, Tottenham, London.

10810. **Improvements in electric tramways.** Rookes Evelyn Bell Crompton, 55, Chancery-lane, London.

10816. **Improved method of installation for electrical conductors within buildings, and cases and appliances therefor.** Henry William Handcock, Alfred Herbert Dykes, and Robert Samuel Lloyd, 28, Southampton-buildings, Chancery-lane, London.

10817. **Improvements in joint blocks or boxes for electrical conductors and the combination thereof with the conductor casings.** Henry William Hancock, Alfred Herbert Dykes, and Robert Samuel Lloyd, 28, Southampton-buildings, Chancery-lane, London.

10836. **Improvements in storage batteries.** Clément Payen, 47, Lincoln's-inn-fields, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1884.

2285.* **Incandescent electric lampholders.** Dornfield. (Second edition.)

1890.

7094. **Applying electrical energy to advertisements.** Upward. (Second edition.)

1891.

15050. **Electrolysis.** Le Sueur. (Second edition.)

19775. **Electrolytic decomposing apparatus.** Breuer. (Second edition.)

1892.

15197. **Electrolytic apparatus.** Andreoli. (Second edition.)

1893.

9295. **Electrolytic apparatus.** Craney. (Second edition.)

12857. **Tanks for electrical decomposition of chloride of sodium.** Richardson. (Second edition.)

14130. **Electrolysis of iodides, etc.** Hargreaves and Bird. (Second edition)

14131. **Electrolysis of chlorides, etc.** Hargreaves and Bird. (Second edition.)

17127. **Electrolytic cells.** Craney. (Second edition.)

19791. **Electrolytic cells.** Hurter and others. (Second edition.)

1894.

9949. **Electrolytic apparatus.** Craney. (Second edition.)

13063. **Electric lighting circuits.** Parfitt.

13160. **Electric cables.** Hardingham. (Felten and Guilleaume.)

13363. **Secondary battery plate.** Buckland.

13594. **Insulating wires for electric heating.** Helberger.

19121. **Arc lamps.** Woolverton.

1895.

3250. **Globes for electric glow lamps.** De Spruner-Mertz and Koch.

4576. **Electric motors.** Brintnell.

5998. **Electric light fittings.** Braham.

6893. **Electrical signalling apparatus.** Lake. (Fiske.)

7245. **Electric railways.** Guest.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5⅜
Brush Company, Ordinary	3	2⅞-2⅞
—— Nom. Cum , 6 per cent. Pref.	2	2¼-2⅜
—— 4½ Debenture Stock	100	113-115
Charing Cross and Strand	5	5¼-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	15½-16
—— 5 per cent. Debenture Stock	100	133-136
City and South London Railway, Consolidated Ordinary	100	44-46
—— 4 per cent. Debenture Stock	100	131-123
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	—
Electric Construction, Limited	2	⅛-⅜
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1⅛ 2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1⅛
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	⅛-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	10-11
—— Preference	10	14-15
—— 4½ per cent. Debentures	100	103-106
House-to-House Company, Ordinary	5	3¼-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅛-7⅜
—— Pref.	—	—
Liverpool Overhead Railway	10	9¾-10
—— Pref.	10	14¾-15½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	⅛-⅜
Metropolitan Electric Supply	10	10¾-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	5⅜-5⅝
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Nom. Cum. Third Pref	5	5¾-6⅛
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	8-8½
Oriental and Electric Company, £1 shares	1	1-1⅛ xd
—— £5 Shares	5	7-7½ xd
—— £4½ shares	4½	5¾-6⅛ xd
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8¾-8⅞
—— 7 per cent. Pref.	5	8¾-9½
Swan United Ordinary	3	1¾-2½
—— 4½ per cent. Debentures	100	105-108
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7⅜-8⅛
Yorkshire House-to-House		5⅛-5⅜

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NOTES.

Swedish Incandescent Lamp Duty.—It is stated that the Swedish Customs duty on incandescent lamps has been raised by about 40 per cent.

Electrical Exhibition at Carlsruhe.—The Grand Duke of Baden has consented to become a patron of the electrical exhibition which is to be held at Carlsruhe in September next.

Rating of Machinery.—Mr. Heneage has given notice on the third reading of the Rating of Machinery Bill to move that the Bill be recommitted to a committee of the whole House.

Electric Omnibus Service.—It is announced that in the course of a few weeks a service of omnibuses, propelled by means of electricity, will commence running between Liverpool street and Hammersmith.

"Vibration of a Battery."—On Tuesday, among the applicants at Greenwich Police Court was a man who said his neighbour had an electric battery, and the vibration was such that he could get no sleep. Mr. Kennedy told him to consult a solicitor.

Society of Arts.—The conversazione of this society will take place at the South Kensington Museum on Wednesday next. The reception will be held by Major-General Sir John Donnelly, K.C.B, chairman, and the members of the council of the society from 9 to 10 p.m.

Obituary.—The Nestor of German physical science, Wirklicher Geheimer Rath Professor Dr. Franz Neumann, recently died at Königsberg at the age of 97. One of his most noteworthy publications was "The Mathematical Theory of Induced Electric Currents," which appeared in 1845.

Book Received.—We have received from Signor Ulrico Hoepli, 59-63, Galleria De Cristoferos, Milan, a copy of "Manuale di Magnetismo ed Elettricità," by Signor Guiseppe Poloni, late professor of physics at the Modena University; second edition, edited by Signor Francesco Grassi, professor of physics at the Society for the Encouragement of Arts and Trade, Milan.

An Anachronism.—In "Harold," the opera composed by Mr. F. H. Cowen, which was produced at Covent Garden Theatre on Saturday last, Harold takes the oath on the relics of a saint in the monastery at Bayeux, the relics being illuminated with the electric light. It has hitherto been generally supposed that the electric light was unknown in the eleventh century, but Sir Augustus Harris knows better.

Royal Meteorological Society.—At the ordinary meeting of the society, to be held by permission of the council of the Surveyors' Institution, at 12, Great George-street, Westminster, on Wednesday, the 19th instant, at 7.30 p.m., the following papers will be read: "Hourly Variation of Sunshine at Seven Stations in the British Isles," by Mr. Richard H. Curtis, F.R.Met.Soc., and, "The Frequency, Size, and Distribution of Hail at Sea," by Mr. Henry Harries, F.R.Met.Soc.

Electric Railways in Japan.—Russia, in return for a certain political service, is just now placing large shipbuilding and machinery orders in France; but Japan does not seem to recognise help from Great Britain in a similarly substantial manner, for German papers announce that the Allgemeine Elektricitäts-Gesellschaft has received a commission from Tokio for electric railway material to the value of several thousands of pounds, and the placing of a second large contract with the same firm is, it is said, imminent.

Loughborough.—In the recent examinations arranged by the local Technical Education Committee, the number of students attending were as follows: geometry, 59; light and shade drawing, 9; model drawing, 11; freehand drawing, 6; hosiery, 12; preliminary electric lighting, 6; perspective, 3; machine construction and drawing, 16; building construction, 11; ordinary and honours electric lighting, 16; mathematics, 73; magnetism and electricity, 54; chemistry, 71; steam, 7; applied mechanics, 8 total, 413.

Personal.—For the appointment of principal of the Wandsworth Technical Institute 134 applications were received, and, subject to confirmation by the Technical Education Board, the governors have elected Mr. William Thomas Allder Emtage, M.A., formerly of Pembroke College, Oxford, to the post. Mr. Emtage is at present professor of mathematics and physics at University College, Nottingham, where he has entire charge of the physical laboratory and superintends the construction of electrical appliances by the engineer students of the college.

New Process of Extracting Gold.—A new process of extracting gold from its ore has been devised by Mr. C. Lorsen. He electrolyses a solution of bromide of potassium and thereby obtains an alkaline solution which contains hypobromide and bromate, which is capable of dissolving gold. The ore is treated with an excess of this solution by rotating cylinders. The solution is then filtered, the gold precipitated by passage over a mixture of iron and coal, and the solution, which now contains bromide of potassium mainly, is once more electrolysed, and again used for extraction.

Electric Lighting of Barracks.—On Tuesday in the House of Commons, in answer to Sir D. Macfarlane, Mr. Campbell-Bannerman said that barrack-rooms were not always crowded. No direct comparisons as to improved health from electric light instead of gas had, so far as he was aware, been made, although the advantages of the electric light were undoubted. Offers to supply the electric light to barracks been made and declined, for the present, at Great Yarmouth and Dover. A succession of experiments in electric lighting had been approved, and plans for providing the light in Colchester hospital and Cambridge lines, Woking, were in progress.

American Institute of Electrical Engineers.—At the annual meeting of this institute the following officers were elected: President, Louis Duncan, Baltimore. Vice-presidents: M. I. Pupin, New York; W. F. C. Hasson, San Francisco; Angus S. Hibbard, Chicago. Managers: Carl Hering, Philadelphia; B. J. Arnold, Chicago; Chas. F. Scott, Pittsburg; Cary T. Hutchinson, New York. Treasurer: Geo. A. Hamilton, New York. The council reported a membership of 944, showing a net gain of 144 members for the year ended April 30 last. The general meeting is to be held at Niagara Falls from the 25th to 28th inst. inclusive.

Railway Development in Russia.—A St. Petersburg telegram states that the special committee which was sent by the Russian Railway Administration to Great Britain, France, Germany, Switzerland, Holland, and Belgium to study the electric railways and latest improvements in electric transit in those countries has just returned to Russia. M. Gortihakoff, the engineer, who is president of the committee, has submitted a detailed report to the Emperor on electric locomotives and the English electric brake. His Majesty endorsed on the report, in his own hand, the following remark: "Very interesting, and desirable to be introduced in Russia, taking the English railways as models."

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Electric Sugar-Refining.—Experiments made by Herr Dammeyer in the sugar mills at Ottleben in refining by means of electricity seem to have resulted satisfactorily, according to the *Elektrotechnische Zeitschrift*. The analysis of the resulting product when electricity was used, with an admixture of 2 per cent. of lime, was: sugar 89 per cent., other organic substances 3·67 per cent., salts 2·65 per cent., water 4·98 per cent. Another experiment, without electricity being employed and with an admixture of 3 per cent. of lime, gave: sugar 86·8 per cent., other organic substances 4·31 per cent., salts 3·31 per cent., water 5·58 per cent. In the electric process there was also a gain in by-products, and crystallisation took place quicker.

Canadian-Australian Cable.—Mr. J. S. Larke, the Canadian commissioner who is now in Sydney, has laid before the Chamber of Commerce there a scheme, which has the support of the Canadian Government, for the laying of a cable between Canada and Australia by the Governments of Great Britain, Canada, and the Australian Colonies. The cost of the cable is stated at £1,600,000, and it is proposed to borrow this sum at 2½ per cent. Mr. Larke states that, placing the charge for cabling at 2s. a word, if the cable secured half the present business it should be able to pay off the whole of the capital outlay and meet an annual expenditure of £125,000 by the year 1919. The Chamber of Commerce will consider the scheme at a special meeting.

"Patenting Made Easy."—Messrs. Iliffe and Son, St. Bride-street, send us a pamphlet under this title from the pen of "A Registered Patent Agent." It is a useful little publication. The author explains that between 15 and 20 per cent. of the applicants for letters patent put such absurd titles to their applications, as shown by the *Official Journal*, that the specifications must be by analogy inaccurate and useless, giving much trouble to the Patent Office authorities and vexation to the inventors. Since these persons would under no circumstances have employed a patent agent, the effect of a perusal of the book will, the author hopes, enable them to put the work in proper form, and, while securing their own interests, save the Patent Office a world of trouble.

Royal Society Conversazione.—The second conversazione, or ladies' soirée, of the Royal Society was held at Burlington House on Wednesday. There were but few electrical exhibits, but a practical demonstration was given by the Postmaster-General of the telephonic communication between London, Edinburgh, Glasgow, Belfast, and Dublin. Mr. A. P. Trotter showed graphically the behaviour of the electric arc under varying condition of volts and amperes. The magnetic tester of Prof. Ewing, for the measurement of hysteresis in iron, was exhibited, as was an improvement by Prof. Roberts-Austen of his electrical furnace. There was also on view Lord Armstrong's collection of photographic prints of various forms of electric discharge in air, without and without applied induction.

The British Association.—The British Association spent a very enjoyable time in Canada in 1884, and the Canadians are putting forward every inducement to bring about another Transatlantic meeting in 1897. Montreal had her turn in 1884, and Toronto, as the rival commercial city of Eastern Canada, is now suggested as the place of meeting. The Dominion Government promises £4,000, and we may be sure that every Canadian railway and steamship corporation would, despite bad times, place its lines at the disposal of the visitors. It is a pity, perhaps, says the *Daily Chronicle*, that if there is to be a colonial meeting every decade the colonies could not be visited in turn; but neither Australia nor South Africa have come forward, and so we may hope that the generous invitation from Canada will be accepted.

Tramways in Paris.—"A very careful and complete report," so designated by the British Ambassador at Paris, has been drawn up by Mr. Graham, one of the secretaries of the Embassy, upon the tramway system of Paris and the Department of the Seine, and has been issued as a parliamentary paper. In forwarding this report to the Earl of Kimberley, the Marquis of Dufferin refers to the fact that it was desired for the information of the London County Council. The report states that a large proportion of the lines is worked by animal power, but mechanical power is making rapid strides. Compressed air furnishes the motive power on the line between the Louvre and St.-Cloud, and on all the lines of one of the companies. Electricity is employed for cars running from the Opera to St.-Denis. The Belleville funicular tramway is worked by an endless cable setting all its cars in motion, and propelled by stationary engines.

Electricity in Bosnia.—On May 1 an electric tramway, 3½ miles long, was opened in the Bosnian capital, Serajevo or Bosna Serai, which has a population of 50,000. The current is supplied through overhead wires, after the patent of Messrs. Siemens and Halske, of Vienna, who built the line. The wires are suspended on artistic iron poles, on simple wooden masts, or on wall hooks, according to the class of street through which the line passes. In many cases the poles also serve to carry the electric lighting cables. The return takes place through the rails. Five motor-cars have been ordered in the first place, and an electric locomotive is being constructed for goods traffic purposes. The tramway obtains its current from the central station in Serajevo, which, simultaneously with the tramway, has been built by the Bosnian Government. In this station there are at present three boilers and three horizontal compound steam-engines, each of 150 e.h.p., and each driving by ropes two Siemens dynamos. One of these dynamos, of a capacity of 75 h.p., suffices for the supply of current to the tramway, at a pressure of 300 volts, the same as for the electric lighting, which is on the three-wire system.

Executions by Electricity.—The *Family Doctor*, a periodical which was started by the same gentleman who evolved that highly aristocratic organ the *Illustrated Police News*, has now taken up the subject of electrocution, and commits itself to the following astounding assertion: "It can scarcely be a pleasant reflection to physicians who have examined the victim of electrocution to realise that they have probably been operating upon a person who was merely physically stunned. There is nothing that goes to show that death took place in the case where men have suffered the penalty of the law in the electric chair. It has been proved that the mind may be quite as active during such periods as at any other, and the thoughts of the victim when the surgeons are cutting him up must be anything but agreeable. After all, while it has its elements of brutality, the old fashioned neck-breaking process of hanging may have points of grace, and is, perhaps, much more sure as a method of taking life than any of the more modern inventions. The guillotine had its compensations, and it might be revived rather than take the risk of the half-way process that the electric current as now applied may be guilty of." It is almost needless to say that the paper in question has no authority for its statement.

French Submarine Cables.—A Dalziel telegram from Paris on Friday last stated that strenuous efforts are being made by the French Colonial Party to force the Government to introduce an extensive system of submarine cables in order to avoid having to depend upon the English

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lines in case of war, a necessity which is declared to be a great national danger. It is now stated that considerable opposition will be offered before the Budget Committee to the renewal of the subventions paid to the English cable companies, of which the principal are the Spanish Submarine Telegraph Company, 1,700,000f. a year for the cable to Senegal; the Eastern Extension Company for Saigon and Tonquin, 300,000f.; the African Direct Telegraph Company, for the West Coast of Africa, 300,000f.; and the Eastern Telegraph Company, the short line from Obock to Berlin, 37,500f. It is contended that this money should be devoted to founding French cable companies. The *Débats* has an article urging the Government to at once lay down telegraphic cables to all the principal parts of the world in order to make France independent of the English lines in time of war. It asserts that Spain, Portugal, Germany, and Holland would be only too glad to transfer their custom to French wires in order to break down the British monopoly.

Light Railways Bill.—On Monday, in the House of Commons, Mr. Bryce formally moved the second reading of this Bill. Mr. Strachey moved an amendment declaring "that so long as light railways are constructed and maintained by Imperial subventions in Scotland and Ireland, no Bill for the construction of light railways in England will be satisfactory which does not provide for like assistance from the Treasury." In support of his contention the hon. member referred to a letter which appeared a short time ago in a daily paper from the general manager of the Belfast and Northern Counties Railway, who had said he was "not sanguine of light railways in England if left to the railway companies and local subscriptions, even though the Board of Trade may make reasonable concessions." The agriculturists of England, the hon. member contended, ought to be treated as generously as their fellows in Scotland and Ireland. Mr. Grant Lawson seconded the amendment. The hon. member was speaking at midnight, when the debate stood adjourned. The debate was resumed on Tuesday on the amendment. Mr. Lawson, who was interrupted on the previous night by the 12 o'clock rule, continued his speech in seconding the amendment, and commented upon the fact that the Bill did not define what was a light railway. Mr. P. Smith thought that the Bill presented a good many difficulties in its financial aspect and otherwise. The hon. member was still speaking at 12 o'clock, when the debate stood adjourned.

Leeds Association of Engineers. — The members of this association have visited the central electric lighting station of the Yorkshire House-to-House Electricity Company, and inspected the recent extension of the plant. Two 400-i.h.p. horizontal compound condensing Corliss engines, with cylinders 19in. and 36in. in diameter by 3ft. stroke, have been added, built by Messrs. Hick, Hargreaves, and Co., of Bolton, and fitted with their high-speed gear. Each has a flywheel 17ft. in diameter, weighing 18 tons, from which is driven by means of ropes a 200-kilowatt Hall dynamo of the multipolar alternating-current type, having seven tons of revolving magnets, and sectional armature. The dynamos work with remarkable smoothness. The total power capable of being developed by all the dynamos is 700 kilowatts, but the foundations are nearly finished for another 400-h.p. engine by Messrs. John Fowler and Co., Leeds, fitted with the Marshall-Wigram gear, which will raise the total electrical power to 900 kilowatts. The working pressure in the mains is 2,000 volts, and the dynamos are self-regulating within about 15 per cent. The company began business about two years ago, with 4,000 lights on circuit, and they have now 26,000 8-c.p. lights. The boiler-house contains six Lancashire boilers, 30ft. long by 8ft. diameter, having mechanical stokers, feed-water heaters, etc., and each capable of evaporating 8,000lb. of water per hour from 212deg. F. About 40 members were present on the occasion, and expressed themselves greatly pleased with the installations.

Electrical Trades Section.—A meeting of the Electrical Trades Section of the London Chamber of Commerce was held on Tuesday last to further consider regulations and conditions for securing the safety of the public, and for ensuring a proper and sufficient supply of electrical energy, made by the Board of Trade under the provisions of the Electric Lighting Acts 1882 and 1888, together with observations made by members of the section in reference thereto. Mr. Emil Garcke occupied the chair. It was stated that a letter had been received from the Lord Chairman of Committees of the Houses of Parliament (in reply to a communication from the section) stating that the protective clause would be introduced in all Electric Traction Bills. A letter had also been received from the Board of Trade extending the time for receiving suggestions about the new regulations to the 15th inst. After some conversation as to the course of procedure to be adopted, Mr. Wright said that a committee of the Institution of Electrical Engineers had drawn up a complete set of regulations, in which very radical alterations had been made on the new Board of Trade regulations and a number of unworkable rules had been excised. A meeting of representatives of the London electric light companies was also to be held that day to consider the same matter. It was decided that the section should go into the matter in committee, the proceedings being private. It was agreed that it was advisable that a joint recommendation should be made by the section, the Institution, and the companies.

Early Atlantic Cable Men.—A special meeting of the New York Chamber of Commerce has been held to witness the ceremony of the presentation to the Chamber of the picture commemorative of the work of the late Cyrus W. Field and his associates in laying the first cable under the Atlantic Ocean. The presentation of the picture was made by Mr. Morris K. Jesup, one of the vice-presidents of the Chamber and chairman of the committee appointed to secure the memorial; his associates being Messrs. Abram S. Hewitt and W. E. Dodge. The picture represents a meeting of the Atlantic cable projectors at the residence of Mr. Cyrus W. Field in Gramercy Park. Mr. Peter Cooper is presiding. Mr. Field is calling attention to a chart of Trinity Bay, pointing to Heart's Content as a safe harbour for landing the cable. Mr David Dudley Field stands by the president with a lawbook. Mr. Chandler White is handing estimates of expense to Mr. Marshall O. Roberts, next to whom, at the table, is Mr. Moses Taylor, listening to Mr. Field's argument. Near Mr. Taylor, at the end of the table, stands Mr. Wilson G. Hunt, who, though he joined them some time after their first organisation, remained a staunch supporter of the project to the end. Prof. Samuel F. B. Morse is standing behind Mr. Roberts, and by his side is the artist, Mr. Daniel Huntington, sketching. The picture is life-size, the canvas being 9ft. long by 7ft. in height. The list of donors includes the estates of Peter Cooper and W. G. Hunt, the Gould brothers, the Western Union Company, the Dodge family, Cornelius Vanderbilt, J. P. Morgan, and about 50 others.

Equipment for Electrical Engineering Laboratories.—A paper on this subject was read some time ago before the Society for the Promotion of Engineering Education by Mr. Dugald C. Jackson, professor of electrical

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engineering at the University of Wisconsin, U.S.A., and he now sends us a reprint of the same in pamphlet form. After dealing with the various apparatus required, he points out that in determining the course of study to be pursued by the electrical engineering undergraduate, upon which the course of laboratory work must depend, it must unfortunately be remembered that he cannot confine his attention to electrical engineering during the whole time given to professional work in his course. He must gain an elementary but practical knowledge of thermodynamics and hydraulics with an efficient knowledge of their application in steam and water power plants. He must also get a common-sense knowledge of the principles underlying the design, manufacture, and selection of machinery. In fact, he must receive a good working knowledge of the problems of the mechanical engineer. Laboratory courses are likely to fail when not properly balanced on account of a failure to educate the common sense or judgment of students, and the students leave the college without having gained an all-round capacity for practical work and research, which is necessary to put them in a fair way to become useful engineers. The knowledge of the electrical engineer must be based on the honest, well-tried mechanical laws, and he must go into a study of all that will aid most in putting him in the way to make a thorough electrical engineer.

London County Council Scholarships. — The Technical Education Board will proceed in July next to award five of its valuable Senior County Scholarships. These scholarships, which are reserved, as a rule, for young men and women under 19 years of age, are intended to enable promising and deserving students, who would otherwise be unable to afford the expense, to go through a three years' course at a university or at a technical institute of university rank. They are limited to those candidates whose parents are in receipt of not more than £400 a year. The scholarships not only give free tuition, but also a money payment of £60 during each of the years that the scholarship is tenable. They are primarily intended to encourage the pursuit of some branch of science, art, or technology; but they may also be awarded for the promotion of studies in modern languages or other branches of education. Four of the scholars who were appointed last year are studying science or engineering at University College, London; Sidney Sussex College, Cambridge; the Durham College of Science, Newcastle; and the City and Guilds Institute in Exhibition-road. The fifth, a lady, is studying at Bedford College. In making the award the Board takes mainly into account the record of each candidate's past career and distinctions, and the evidence as to ability, industry, and good character, which the candidate is able to supply. At the same time it reserves the right to apply any examination test that it may think fit. Full particulars may be obtained from the secretary of the Board, at 13, Spring-gardens, S.W. Candidates should send in their names not later than the 29th inst.

Cable Stations.—We have received the June issue of the *Windsor Magazine*, which, among other interesting matter, contains an article by Mr. Roland Belfort, entitled "At an Atlantic Cable Station." It deals with the Commercial Cable Company's Hazel Hill Station, Nova Scotia. The writer points out: "Though the receipts from the cable are good, the expenses are very heavy. The costly transmitting stations in Canada and Ireland do not earn a penny directly. The cables average £250 per mile, the delicate instruments cost from £50 to £200 each, the expenses of executive management amount to about £10,000 per annum, the managers draw from £500 to £800 per annum. The stations being 3,000 miles apart, travelling expenses form a serious item. Repairing expeditions are ruinous; £35,000 was sunk in one expedition that failed, another ship had to be employed at £500 per day. Cables break. Four were broken down simultaneously by an extraordinary seaquake — a violent submarine eruption; whales get entangled with them. Once a schooner settled down on one and broke it. Ships' anchors break cables in shallow water; fishermen bent on a 'catch' will drag for a cable, hook it, and then claim compensation for not having cut it to save their anchor and chain! On one occasion a cable was wilfully cut off Newfoundland. The culprits were strongly suspected, but conviction would have been difficult and costly. Cables have been buried for miles in submarine ravines and lost. Even the landing rights in France cost this company £8,000 and three months' tedious negotiations. They got similar facilities in England for £1, and a polite letter to the Board of Trade! The repairing ship cost £60,000, and often absorbs £500 per month to maintain her ready for sea at a moment's notice."

Electric Traction in India.—*Indian Engineering*, which ought to know better, in advocating steam traction for the Madras tramways, commits itself on the subject of electric traction to the following opinions, which contain a large proportion of unjustifiable assertions: "The flatness of Madras is all in its favour for laying tramways; the inhabitants being scattered over a considerable area, or some 30 square miles, makes it a relatively somewhat costly matter. Coal also has to be brought a long way and firewood is scarce. Under these circumstances an electric system of propulsion, in which fuel would be used to generate electricity, and the latter be distributed over lengthy strains of wire to deliver a percentage of the original horse-power (and at, of course, an enormous wastage of it), would be about the last to commend itself to the cautious investor of his shilling-rupees. Insulated wires put at the ground level readily dissipate the current, and both guttapercha and indiarubber are as sensitive to the Indian climate as the European constitution. The first cyclone must, on the other hand, flatten the whole network of overhead wires, which are as complete and airy as a cobweb; so that there is nothing except the rails and cars left which is not, in the case of electric power being employed, at hourly risk of breaking down or perishing. All the circumstances of Madras point to a steam tramway of some kind. . . . If the shareholders of the Madras Electric Tramway were to get direct steam traction adopted without the profitless intermediary of a host of silk *(sic)* and guttapercha covered wires, they might even yet find themselves in possession of a very valuable property." These remarkable utterances prove that the hymn which asks for the inhabitants of "India's coral strand" to be delivered from "error's chain" is not unjustified.

Property and Income Tax.—The Income Tax Adjustment Agency, 12 and 13, Poultry, E.C., write to us as follows: "With the income tax standing at a rate equal to $3\frac{1}{3}$ per cent. on one's income, it is of importance not to neglect to obtain all the relief in one's power. May we, therefore, be permitted to remind your readers that if for the last three years' trading the average of their profits was less than the amount on which they paid tax for 1894-5, they should at once claim repayment of the sum overpaid, otherwise they may lose their right to do so. If the profits of the last year exceeded the average (including the year) they cannot obtain any refund. By appealing now the assessment for the ensuing year will be settled also, as the assessment as amended for 1894 5 will in most cases stand good for 1895 6. A claim to set off a loss made

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in farming or business against profits or income from any other source should be made immediately, while farmers claiming a return of tax paid under Schedule B by reason of their profits being less than the amount they have paid on must lodge their claims before July 6. Persons whose incomes from all sources for the year 1894-5 did not exceed £160 are entitled to exemption, those whose income did not exceed £400 to an abatement of £160, and those whose incomes did not exceed £500 to an abatement of £100. Claims for exemption or abatement may with few exceptions still be made in respect of the years 1892-3 and 1893-4, even when the income is said to be 'free of income tax,' where the incomes did not amount respectively to £150 or £400, as also for tax on life insurance premiums. The amount recoverable on abatement alone for the three years amounts to £11. 16s. 8d. A wife's income derived from a profession, employment, or vocation, where the joint income did not exceed £500 for 1894-5, is to be dealt with separately, the effect of which may be to give two abatements off the joint income, when the tax recovered for 1894-5 alone would amount to £10. 13s. 4d."

American Electro-Therapeutics.—There appears to be a "boom" in electro-therapeutics on the other side of the Atlantic, which is conspicuous by its absence on this, says the *Lancet*. Nor is it a mere fashion of the day; there is solid work behind it. The American Electro-therapeutic Association is evidence of this. Established on the usual lines of other medical societies, this association presents one very exceptional feature. The fellows "shall either be practitioners of medicine of good standing or electrical experts." The wisdom of such a rule may be open to question, but its aim is obvious and its intention excellent. It proclaims a due recognition of the principle that in electro-therapeutics "the physical problem underlies the biological one," and its object is to attain a higher standard of medical education in the physics of electricity. The annual report of the society's transactions for 1894 does not seem yet to have reached this country, but in 1893 the association consisted of about 80 fellows. Its various committees then submitted reports on standard coils, standard meters, static machines, constant-current generators and controllers, electrodes, etc. The latter committee appears to be a standing one, and furnishes an example of painstaking and methodical work. Its chairman has addressed a circular which now lies before us, "to every manufacturer of electro-therapeutic apparatus whose address is known" in order to secure "the universal adoption of uniform connections, a standard gauge of screw throughout construction, and efficient, durable, simple, and interchangeable electrodes." The report of this committee and the discussion thereon will form part of the proceedings of the society at its meeting in Toronto on September 5. Such a committee has much useful work before it. If in electro-therapeutics results are to be compared and a definite procedure followed, there is an evident necessity for the use of electrodes of a definite size and shape, easily procurable, and with distinctive designations. It is evident, for example, that a current strength (intensity) unbearable through an electrode of a certain size may be easily and painlessly passed through one of a greater surface area. It is long since the necessity for standard electrodes was recognised and advocated by Erb. Important steps in this direction were taken at the society's meeting two years ago, and it was also recommended on that occasion that all connections be by "standard hole and pressure screws." The adoption of this simple detail would "soften the lot and sweeten the temper" of many a practitioner sorely tried by the treacherous and even dangerous insecurity of certain "plug and socket" connections.

Telephone Trunk Lines.—The first and most important stage in the establishment of a telephone system for the United Kingdom in conjunction with the Post Office was completed on Wednesday, when the great trunk lines erected by the Department were inaugurated, and London was for the first time put into telephonic communication with Edinburgh, Glasgow, Belfast, and Dublin. The work has been carried out on the principles contained in a Treasury minute, dated May 27, 1892, when the late Government proposed that the operations of the licensed telephone companies should be confined to towns or defined areas, the trunk lines being worked by the Post Office. The details of the arrangement with the private undertakings for the transfer of their property are still the subject of an investigation by a Parliamentary Committee, but the Department has made ready to take over the working of the independent concerns by erecting the vertebrate system to which they will be attached. The most easterly wire from London runs to Ipswich, by way of Chelmsford and Colchester, and the most southerly to Brighton, two wires being used in each case. The Midlands are served by a line of from sixteen to four wires, passing through Nottingham, Sheffield, and Leeds, to Newcastle, and feeding Derby, Birmingham, and Leicester from Sheffield and Nottingham; Manchester and Liverpool, on the one side, and Hull on the other, from Leeds; and Hexham and Morpeth from Newcastle. At Birmingham the line is taken south-west to Newport, Cardiff, and Swansea, and, by another network, to Bristol, Exeter, and Plymouth. At Leeds, the communication strikes off to the north-west, and passes through Carlisle to Glasgow and Edinburgh, for Scotland, and to Portpatrick, where a submarine cable across St. Patrick's Channel is laid to Donaghadee, and touch is gained with Belfast and Dublin. These lines are already completed and in working order; but there is still in progress a system direct from London to Birmingham, leading on to Derby, where it will branch to Liverpool and Manchester, passing through Cottonopolis to a point where it will join the Leeds-Carlisle communication. The direct service from London to Bristol, Southampton, and Portsmouth will be secured by six wires running to Salisbury, where they will separate, four turning to the Bristol Channel and two to the Solent. A couple of wires from Newcastle to Sunderland, and two more from the same centre to Darlington and Stockton, will complete the scheme of the Department. Altogether, a total of 10,375 miles will be covered, and 2,829 tons of copper will be consumed, in the following proportions: 2,719 miles, at 800lb. of copper per mile per wire; 4,914, at 600lb.; 2,646, at 400lb.; and the submarine cable, 24 miles in length, which, being quadruple, gives a total of 96 miles. The mileage at present completed is 7,595 miles. The extent of private undertakings to be presently absorbed is about 28,000 miles. The distance to Dublin, as traversed by the wire, is 467 miles, which is a notable increase on the 334 miles followed by the railway from Euston *vid* Holyhead. The longest circuit over which the Post Office authorities have spoken by linking the largest possible number of wires is 1,270 miles, and the result of the experiment was quite satisfactory. It is expected that the new system will be open to the public in a few days. Wednesday's inaugural ceremony took place at the new building, known as the General Post Office North, when communication was first established with Edinburgh, then with Glasgow, Dublin, Belfast, and Nottingham. The voices were heard with the greatest distinctness over the longest distances, and one gentleman in Edinburgh subsequently amused the company by singing "Auld Lang Syne" and giving a whistling recitation.

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THE CONTINUOUS-CURRENT DYNAMOS OF MM. F. BALAS AND L. COUFFINHAL.*

BY P. GIRAULT.

For a long time—say, from the date of the first really industrial applications of electricity to lighting—engineers have been anxious to reduce to a minimum the uncertainty arising from the responsibility left to the staff in charge of the machinery.

From a mechanical point of view, we have been led to use completely automatic lubricating apparatus. In steam-engines, the extension of electric lighting has been the cause of the continued progress achieved in the construction of governors.

The method which suggests itself at first sight of maintaining constant the pressure or voltage of a distributing system consists in connecting to a dynamo a special apparatus which, being affected by the variation of the voltage, produces automatically the desired regulation.

For distribution at a constant potential, the theoretical apparatus would comprise a very sensitive relay acted on by the variations of potential at the terminals of the machine or at the centre of distribution, working by means of a motor the handle of the exciting rheostat; the relay might be a voltmeter furnished with contacts which change the direction of the current in the armature or the field of the motor, accordingly as the voltage increases or decreases. These apparatus, fulfilling a part analogous to that of the Denis compensator in steam-engines, are perfect in principle. The great practical difficulty is to obtain at the same time sensitiveness, a sufficiently great speed, and a damping gear, so that the regulator does not sensibly overrun the correct position.

The principle of the pressure regulator of the Thomson-Houston dynamo has been followed by a great number of continuous-current dynamo builders aiming at constant pressure. They employ, in fact, apparatus producing a variable position of the brushes. The results are not very satisfactory, for the collectors are subject to destructive sparking, which is the more prejudicial as these machines are generally required for the production of high-tension currents. It would be much more rational to vary the excitation, for example, by a resistance shunting the magnet coils when it is a series machine. The chief advantage in shifting the position of the brushes is an almost instantaneous regulating effect which can be obtained.

Self-Regulating Dynamos.

Consideration of the characteristic curves of dynamos showed the possibility of compound machines, furnishing a practically constant difference of potential at the terminals, whatever the load may be, if the speed is maintained constant; but only an average voltage is thus obtained, the variations of which can be considerably reduced in proportion as the reaction of the armature is reduced.

This reaction of the armature, necessitates also a shifting of the brushes increasing with the load, and has caused a number of numerous barren discussions. In 1890, Prof. S. P. Thompson, introducing the consideration of the cross-induction, supplied a hypothesis which has since been justified by results. Herr Fischer-Hinnen published in the *Elektrotechnische Zeitschrift* an interesting article, in which he showed how this transverse induction could be predetermined, and described the practical methods to be used to diminish or suppress it, and which can be divided into two categories: (1) those destroying the action of the current traversing the armature by opposing to it an equal opposite magnetising force—*i.e.*, compensating coils; (2) those presenting to the transverse induction a magnetic resistance, which considerably diminishes it—*i.e.*, by slitting the pole-pieces.

The use of compensating coils gives the more correct results, but somewhat complicates the construction. The practise of slitting the pole-pieces presents certain difficulties. M. Guilbert has described in *La Lumière Electrique* the method employed by M. Labour, engineer of the Société d'Eclairage Electrique. The pole-pieces are cut in two, and the two halves are united by cast-iron ribs, offering considerable magnetic resistance.

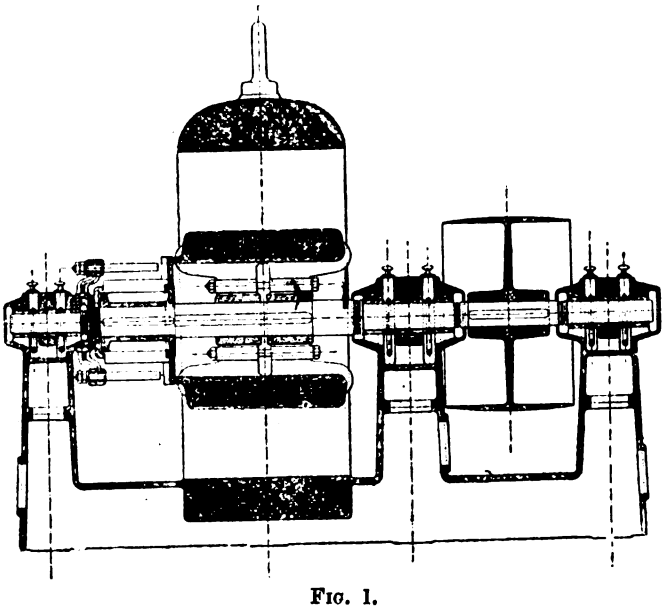

Fig. 1.

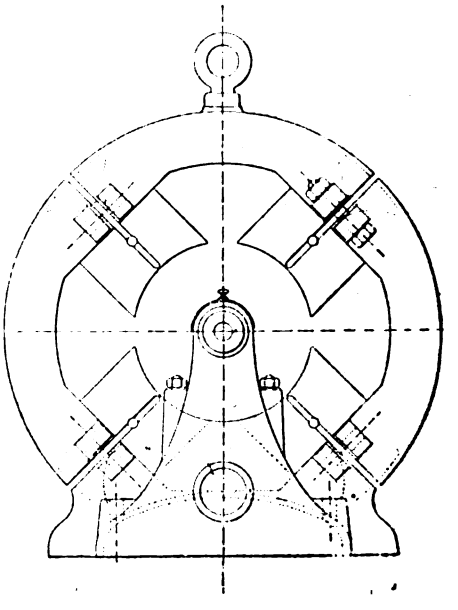

Fig. 2.

MM. F. Balas and L. Couffinhal, electrical engineers, of Chaléassière, Saint-Etienne, completely divide the body of the magnets by air-gaps passing through the axis which divides them into two equal parts; the two halves are separated by a non-magnetic metallic plate offering to the transverse fluxes an air-gap, as shown in Figs. 1 and 2.

A 55-kilowatt dynamo made by MM. Balas and Couffinal has been fixed in the electric central station at Saint-Etienne, and supplies on a full load a current of 500 amperes at 110 volts at 500 revolutions per minute. It is of the four-pole type. Figs. 1 and 2 show respectively the longitudinal sections of the armature and the field magnets of this dynamo. The foot of the bearing pedestal is a surface turned concentrically with the bore of the pole-pieces. Lubrication of the bearing is automatic, and of the Decoster ring system, the oil being circulated by eccentric rings hung on the shaft.

The armature is of the Gramme ring type, the core of which is composed of soft iron plates 0·0078 square inch thick. These plates are first coated with coal-tar oil to prevent rust, which often penetrates the insulating material. They are afterwards piled upon two bronze spiders, each plate being separated by a very thin sheet of paper. The two spiders are afterwards fixed on the shaft, upon which they are keyed and firmly pressed together by six steel bolts. These bolts are placed comparatively close to the shaft so that they neither obstruct the windings, nor are subject to Foucault currents.

* From *L'Industrie Electrique.*

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The core thus formed is insulated along its periphery by means of two superposed cloths covered with bitumen, between which are placed thin sheets of mica; upon the lateral face and in the interior, insulation is obtained with vulcanised fibre. The plates of the collector are insulated by mica. The section of the iron of the ring—that is to say, that through which the whole of the flux emanating from one pole passes—is 76·725 square inches without the insulating material. The induction admitted is 12 kilogauss. The outside diameter of the core is 21·079in. It is wound with a conductor in 120 sections of two turns each, the conductor being formed of four parallel wires, each of 0·113in. diameter, insulated by two layers of cotton, then gum-lacquered.

The framework of this four-pole machine consists of four pieces of soft cast iron, the planes of intersection passing through the axis of the machine and dividing the pole-pieces into two equal parts. These four portions of the framework are supported one on the other only by the bronze block separating them, so that between the two contiguous pieces of cast iron forming a pole-piece there an empty space of two centimetres constituting a very strong resistance to the transverse fluxes. These four pieces are connected together by eight bronze bolts pressing upon ear-pieces fixed above the place reserved for the magnet coils. These bolts go through the bronze plates and the cast-iron ear-pieces. The lower segment of the magnet is cast with the foundation plate.

The induction in the cast-iron portions of the magnetic circuit is six kilogauss. This induction and that of the armature area are perhaps a trifle weak, and for this reason the dynamo is heavy, but the builders estimate that this weight is necessary for the machine.

The section of the cast-iron circuit is 206·15 square inches for the total flux emanating from one pole. Its length is 47·28in. The diameter of the boring of the pole-masses is 22·14in., which gives 1·064in. as the total length of the air-gap. The electric losses are 1,100 watts in the magnet and 2,100 watts in the armature. The cooling surfaces are—1·86 square inch per watt wasted in the magnet-coils, and 0·775 square inch per watt lost in the armature, counting only the surfaces which are well ventilated. The excitation required by the four magnet-coils in open circuit is 20,600 ampere-turns, which is obtained with a current of 9·2 amperes through 2,240 turns of wire of 0·121in. diameter insulated by a layer of cotton; at full load a supplementary excitation of 1,800 ampere-turns only is required on the four pole-pieces for compensating the reactions of the armature.

Although no extensive trials have yet been made with these machines, MM. Balas and Couffinhal believe that they can easily obtain a commercial efficiency of 92 per cent. What is more important is the absolutely safe running of these machines, the lag being absolutely nil whatever may be the load. This is a very appreciable quality in central stations of average size subject to quick variations of load.

THE QUALITIES OF MANGIN AND PARABOLIC MIRRORS.

With reference to the article on projector mirrors, which appeared in our issue of 17th ult., we have received the following communication from Herr F. Nerz, of the Elektricitäts-Gesellschaft vormals Schuckert und Co., of Nuremberg:

Experiments were made by the French Government in January last at Toulon, with the result that the parabolic mirrors of Messrs. Schuckert and Co., of Nuremburg, were found to be superior to the Mangin mirrors of Messrs. Sautter, Harlé, et Cie., of Paris. Trials by other States between 1889 and 1895 have without exception had the same results. That any Government, especially the French, would take the part of the German industry against a native industry is doubtful. The French Ministry of Marine, on the contrary, gave the greatest consideration to the home industry, and only this consideration can have determined the fact that, in spite of all experiments, the Mangin mirror is still used in the French navy. At Toulon and Ismid, Messrs. Sautter, Harlé, and Co. have returned the Mangin mirror in the possession of the arsenal as being unsuitable for purposes of comparison, and supplied new Mangin mirrors in new apparatus from Paris.

In order to weaken the results of the experiments, and to reverse the decision of the public, Messrs. Sautter, Harlé, and Co. have in the *Electrical Engineer* of 17th ult. a treatise which is so far from the technical calculations and the results of practice that it is advisable that a correction should be set before your readers.

In paragraph 1 of their pamphlet, Messrs. Sautter deal with the parallelism of the reflected rays, and grant that in the Mangin mirrors manufactured by them the focal length of the single zones deviates by 0·5 millimetre. Against this, the false assumption is made that in parabolic mirrors the focal points of the single zones also do not coincide, and that often there is a deviation of 1·5 millimetres. As a matter of fact, the deviation stated by Messrs. Sautter-Harlé does not exist in the parabolic mirrors which for a number of years have been made by Messrs. Schuckert. The silvered surface in these parabolic mirrors has such a focal length that all the original parallel incident rays are reflected up after reflection on this hinder surface from the front surface, so that they meet in the focal point of the front surface. Messrs. Sautter-Harlé would do well to state what sort of mirror is referred to, as their assumption does not exist in parabolic mirrors in practical use.

In paragraph 2, Messrs. Sautter-Harlé deal with the dispersion found in using an arc lamp with horizontal carbons. They forget therein that the projection of the crater disc on the surface of the mirror is bounded, not by a half moon, but by an ellipse. They further forget that for the dispersion, not only the small axis, but also the larger axis is to be taken into consideration. They also forget that by moving the focal point for a given part of the mirror surface, or by an alteration of the revolving surfaces according to determined laws—work which, contrary to the view of Messrs. Sautter-Harlé, could be more easily carried out with paraboloids than with the circular sections of the Mangin mirror—the beam is more intense towards the middle, and consequently weaker at the edge, and that therefore the field would be irregularly illuminated. The irregular lighting of the field has, however, hitherto been sharply found fault with, not only by Messrs. Sautter-Harlé, but also by Prof. Blondel. Further, Messrs. Sautter have hitherto brought forward as a special merit of the Mangin mirror the slight working arrangements, whereas now in the promised alteration of the surfaces of the Mangin mirror they arrive at complicated working parts, thus giving up their boasted advantage. Finally, prominence must be given to the fact that the arc lamp with horizontal carbons has hitherto been strongly combated by Messrs. Sautter-Harlé as being totally useless for projectors.

In paragraph 3 the firm refer to the angle of collection, but forget the practice adopted for years that the focal length is smaller in a parabolic mirror than in a Mangin mirror of the same diameter. Messrs. Sautter-Harlé's deductions from Figs. 4 and 5 are, therefore, not drawn for technical people who are versed in the manufacture of mirrors. The same holds good for the calculation of the intensity of the field lighted, as this is only correct for the central portion of the mirror, which generally receives no light. With the same angle of collection the Mangin mirror suffers at the thicker edge by absorption and decomposition of the rays, forming spectra. In central zones, also, there is trouble from absorption, and in a smaller degree by spherical aberration and decomposition, against which the parabolic mirror only suffers from dispersion.

In paragraph 4, the heating of the mirror by the arc is referred to. Messrs. Sautter-Harlé ignore that the Mangin mirror has globular surfaces and becomes thicker and thicker towards the edge, and that, further, the danger of breakage is greater than in a parabolic mirror, in which the thickness of the glass is uniform. When these points are examined, a parabolic mirror of 279mm. focal length is superior to a Mangin mirror of 318mm. A projector of

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60c.m. diameter with horizontal lamp, however, reaches first its highest capacity with a collecting angle of 124deg., answering to a focal length of 250mm. This angle of collection is not obtainable in the case of the Mangin mirror.

In paragraph 5, Messrs. Sautter-Harlé discuss the homogeneity of the reflected beam. The theoretical calculations show here a superiority for the Mangin mirror when accurate mathematical surfaces are taken. But the theory suffers in practice through inaccurate grinding. The Mangin mirror has, I understand, been rejected by Switzerland, among other grounds, mainly on account of its low homogeneity, and the parabolic mirror has been selected. Besides, complete homogeneity is not at all desirable. What is much more required is to secure a strong light in the centre of the illuminated field, and to take something off of the borders. Then the observer can from his standpoint at some distance from the mirror most quickly and safely look up the desired object, and will not be dazzled by the outer rays of light. Notwithstanding these practical experiences, Messrs. Sautter-Harlé advocate an equal illumination, and give the operator the difficult task of looking for distant objects most possibly with the outer rays. The polishing method in the manufacture of parabolic mirrors at Messrs. Schuckert's works is so perfect that the illuminating power of the beam is graduated according to practical requirements. The concentration of the beam in the Mangin mirror, as well as in the parabolic mirror, is determined by the equation $D = d \cdot e \cdot f$. D is the diameter of the illuminated field; e the distance of the field from the mirror; d is the diameter of the crater; and f the focal length. From this is derived the long-known fact that, within certain bounds, by the approach of the crater the dispersion in both mirrors is increased without diminishing the homogeneity.

In paragraph 7, the coloration in the Mangin mirror is acknowledged, but an erroneous declaration is made by Messrs. Sautter-Harlé in connection with the coloration not being visible at greater distances. This is not due to the decomposed rays being united, but to their being absorbed by the atmosphere, as the penetrability is far less for coloured rays, especially green and blue, than for white rays. The coloration therefore is a loss which does not exist in connection with the parabolic mirror.

A further error is made (paragraph 8) in the calculation of the absorption in the Mangin mirror. This absorption is given in "Théorie des Projecteurs Electriques," by Blondel and J. Rey, chief engineer of Messrs. Sautter's firm, as 0·985 per cent. for glass of 1cm. thickness. We thus have, according to the Blondel formula, 5 per cent. loss for glass 5cm. thick, and not 3 per cent., as stated by Messrs. Sautter.

A great mistake is made by the firm in connection with the durability of the mirror. As in the case of an oil or gas lamp, a thin cylinder of equal thickness is more durable than a thick cylinder of unequal thickness, so the influence of heat is better withstood by a parabolic mirror than by the Mangin mirror, which increases in thickness towards the outside. This consideration is confirmed in practice. Among all the parabolic mirrors in use in the German army not one has received injury in use, though one was damaged by carelessness when not being used Out of 550 parabolic mirrors sent to different parts of the world, none has been damaged, save by carelessness. In one instance the whole projector was upset from a wagon, causing even iron parts to be broken, but the parabolic mirror remained uninjured. What experiences can Messrs. Sautter-Harlé give to compare with these?

In paragraph 10, Messrs. Sautter-Harlé express themselves on the manufacture of parabolic mirrors, but conceal the fact that they do not know the only proportional method of production in the world, which is carried out at the Schuckert works. This method of production is protected by many patents in all leading countries, but, in addition, many important details are kept secret. The difficulties of production, the inaccuracy of machinery, the faulty handicraft of the workmen, which Messrs. Sautter would doubtless meet with in the case of a new contrivance, have been overcome in the 10 years' working of Messrs. Schuckert. At the present time the workmen, when the machines have been put in, have only to bring up lubricating oil and polishing material and attend to the forward and reverse movements. This work may last longer and be more difficult in the case of parabolic mirrors than in that of Mangin mirrors. This is, however, all the same to buyers as long as the product of the work, the parabolic mirror, is essentially better and not dearer to any appreciable extent than the Mangin mirror. What the Mangin mirror saves in labour is counterbalanced by dearer material. The differences given by Messrs. Sautter-Harlé in the focal length of the different zones, as well as the calculated angle of dispersion, do not occur in the Schuckert parabolic mirror. I therefore can find no other explanation than that either Messrs. Sautter-Harlé have themselves tried to produce a parabolic mirror, or that they are directing their attack against the competition which has arisen with them in France.

The figures relating to the parabolic mirrors of Messrs. Schuckert have been published by me in No. 27 of the *Elektrotechnische Zeitschrift*, 1894, together with a table. It was there shown that the dispersion of a mirror of 600mm. diameter, and 250mm. focal length, at 60 amperes and 12·1mm. crater diameter is 2° 47′, and not 2° 20′. The values given in my table are guaranteed in all Messrs. Schuckert's deliveries, and as far back in 1890 for all the projectors for the Belgian forts on the Maas.

The experiments of Herr Tschikoleff in connection with the Russian artillery show the severity of his method, while the extent of the error is now recognisable from the reflected-line system. On the grounds of these experiments, Tschikoleff gives in No. 13 of *L'Eclairage Electrique*, 1894, the following testimony: "Since 1889 there have been commenced to be installed in the forts parabolic projectors in glass by Schuckert and Co., of 94cm., the advantages of which, compared with those of Colonel Mangin, were established by very careful experiments at the Cannon Works and at the Grand Polygone de l'Artillerie . . . The most powerful electric projector which we possess is the Schuckert glass parabolic projector, about 940mm. in diameter." As regards this 940cm. mirror, 40cm. belong to the frame, so that really a 900mm. mirror should have been referred to.

In *L'Eclairage Electrique*, p. 54, photographic tests of projector mirrors were given (see *Electrical Engineer*, April 19 last), in which a photograph was wrongly attributed to a Schuckert mirror. Herr Tschikoleff wrote to that journal pointing out the mistake, his test referring to a mirror made by another firm, and he stated that he had never met with a Schuckert mirror so imperfect. I have in vain looked for the correction in *L'Eclairage Electrique*.

It will be obvious to your readers that the whole pamphlet of Messrs. Sautter, Harlé, and Co. is of a polemical character, which ignores the teachings of science and technical experience.—F. NERZ.

THE MECHANICAL PRINCIPLES OF ELECTRICAL ENGINEERING.*

(Concluded from page 664.)

In the instance previously referred to the hourly output of the destructor amounts to 300 horse-power hours, or 300×24 horse-power hours per diem, or $\frac{300 \times 24}{8}$ horse-power hours per hour during eight hours. If this can be done, then 900 h.p. would be available to meet the maximum demand of 550 h.p. for electric lighting required in an initial installation. Although this may be taken as an instance in which the demand for power is intermittent, the generation of electricity for lighting is by no means the only case in which power storage would prove invaluable. Unless some means can be found for storing the energy in some form or another, the greatest constant duty that could be imposed on the destructor would be equivalent only to the minimum energy that the furnaces furnish. It would be another matter if some fresh and unexpected demand for power were to crop up, such that its magnitude varied

* An address delivered to the students at the Croydon County Polytechnic by Mr. H. B. Ransom, A.M.I.C.E.

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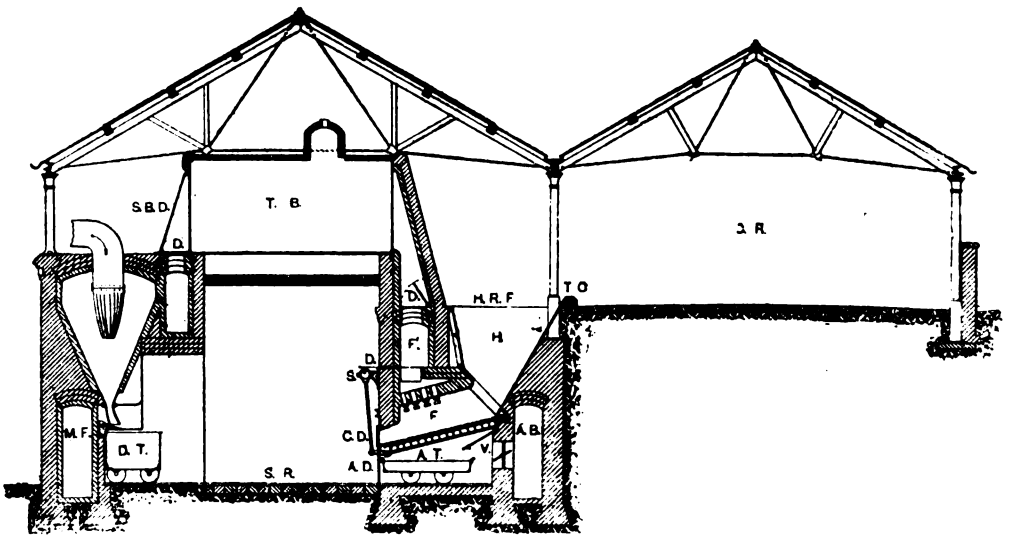
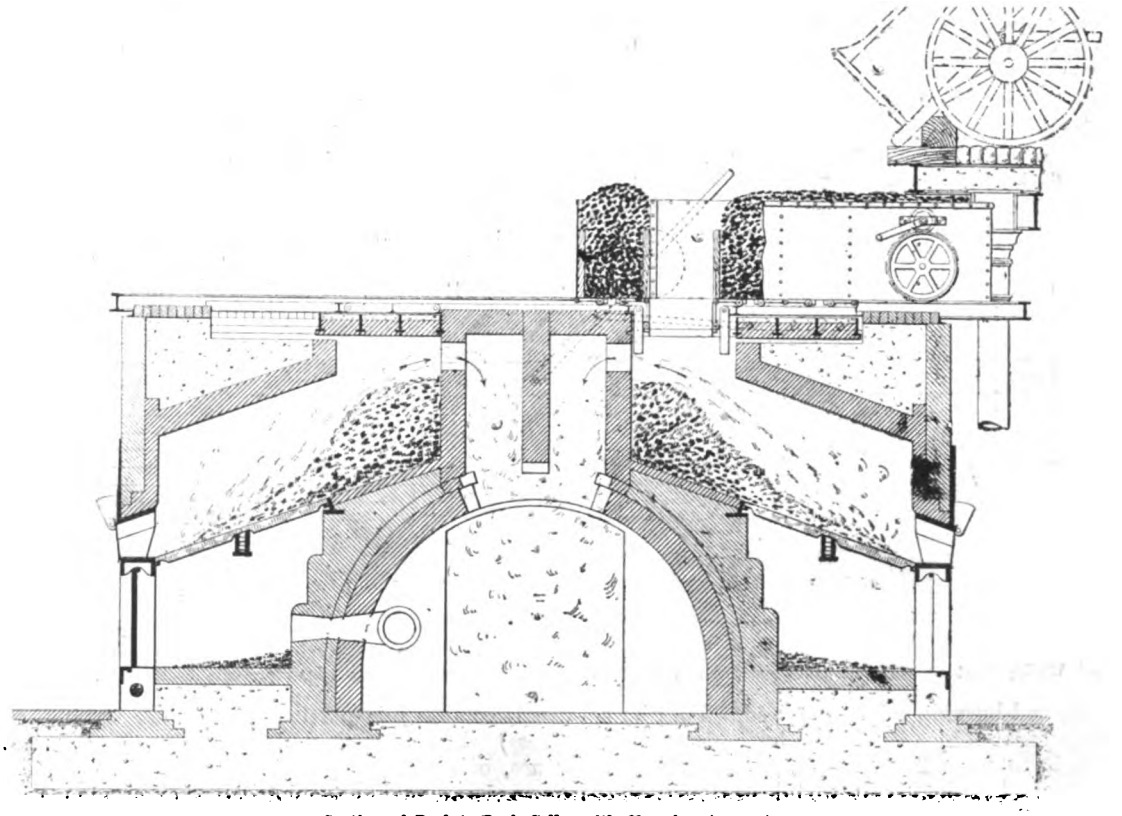
coincidently with the heat derived from the refuse, but such a demand is almost inconceivable. It has been proposed to utilise it for sludge-pressing or pumping sewage; but neither of these suggestions recommend themselves as suitable duties for refuse furnaces unaided by any storage scheme, owing to the unfortunate coincidence that both the sludge to be pressed and the sewage to be pumped have to be dealt with as delivered, and the maximum delivery corresponds precisely with the minimum generation of heat from the refuse, saturated as it is at such periods by the heavy rainfall.

Several modes have been suggested for the storage of energy continuously generated by destructors. It has been proposed to establish large high-level reservoirs into which water might be pumped. Prof. Forbes brought this scheme into great prominence when discussing the available means for lighting Edinburgh. In this instance, Arthur's Seat was proposed as the site for the water storage, and the falling water was to drive turbines. Presumably, this scheme was too expensive, for little has been heard of it for some years, and the city already possesses its own lighting scheme. The same objection applies to the adoption of electric storage, for although batteries can now be made to work at a high efficiency, their cost usually precludes their use on any very large scale. The third method of storing the spare energy of the destructor owes its origination to Mr. Druitt Halpin, M.I.C.E. It is assumed that sufficient boilers will be placed in connection with the furnaces to reduce the temperature of the escaping gases to about 500deg. F. before reaching the chimney. These will be constantly generating steam at a pressure about 100lb. per square inch higher than that used in the engines. This steam will be passed into a sufficient number of cylindrical receivers or reservoirs nearly filled with water, which will be gradually raised in temperature and to the pressure of that of the incoming steam. Assume that this water be raised to 250lb. pressure during the 16 hours when electric light is but little required, and assume that the engines are at work at 150lb. pressure. Then during the eight hours' heavy load the engines will be able to use the steam that is then being generated by the destructor, and, in addition, steam may also be drawn from the reservoirs by merely relaxing their pressure. We do not propose to go fully into Mr. Halpin's



Sectional View of Arrangement at Salford.

C R Covered Roadway for Refuse Carts.
T C Tipping Curb.
H R F Horsfall Refuse Furnace.
H Hopper.
A B Air Blast.
V Valve.
A T Ash Truck.
F Furnace.
F' Flue.
D Damper.
C D Clinker Door.
S Shaft for Moving the Grate Bars.
A D Ash Door.
S R Sunk Road and Tramway for Clinkers, Ashes, and Flue Dust.
T B Tubular Boiler.
D T Dust Track.
M F Main Flue.
S B D Smoke-box Door



Section of Back-to-Back Cells, with Charging Apparatus.

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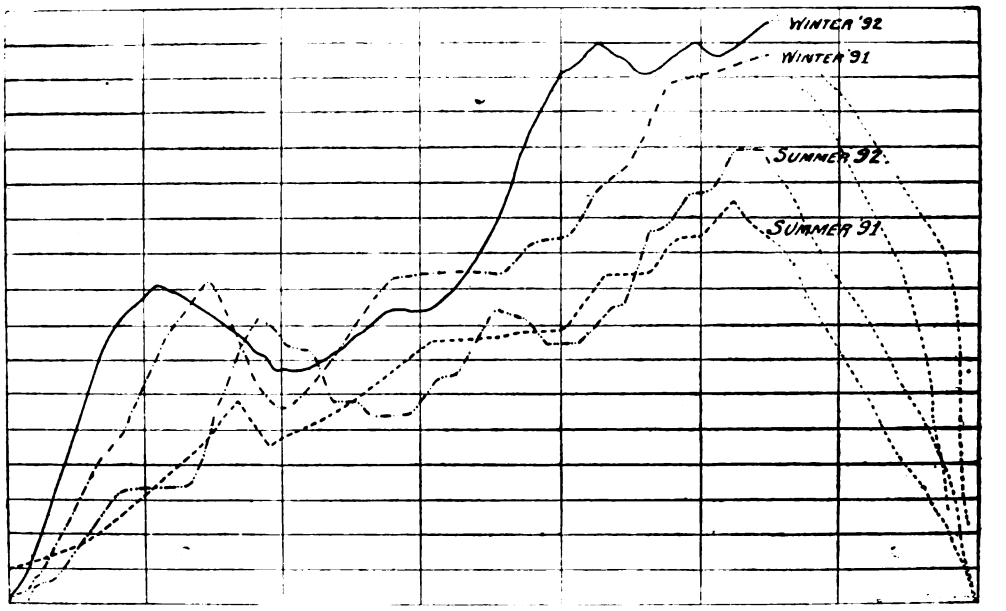
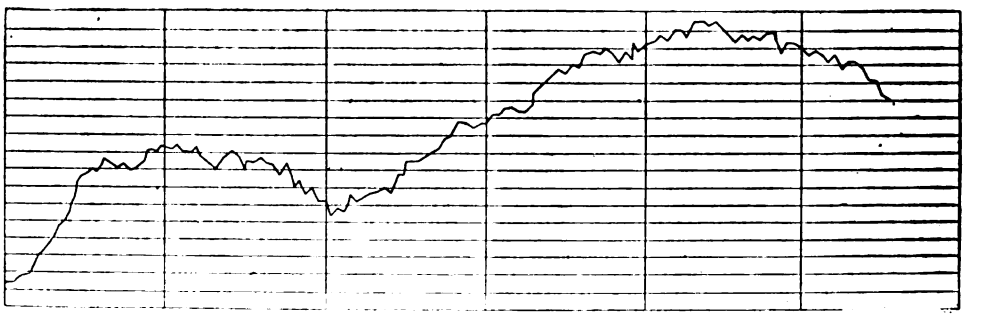
"thermal storage," but it will not be out of place to indicate a very important advantage which this method of dealing with the question entails. It clearly becomes only a question of pipe-work arrangement to secure all deposit from hard water taking place in the reservoirs instead of in the boilers. Incrustation in the reservoirs becomes in this instance an advantage as a non-conductor, instead of the dangerous and costly evil it would be did it occur in the boiler. Although this scheme has not yet been put to the test of actual practice, there appears to be little doubt that it will be applied before long, and, according to the opinion of many experts who have examined it with considerable care, with every prospect of success. Its practicability is also to some extent confirmed by the successful working of a system of transmission of power by hot water now in use in Boston, U.S.A. In this instance, according to Mr. T. L. Miller, A.M.I.C.E., in a presidential address to the Liverpool Polytechnic Society, a 4in. supply pipe has been laid round a district, with an 8in. return to the boilers. The water is heated to about 400deg. F., and for power purposes it is allowed to flash into steam at 70lb. pressure. It is further stated that as the pipes are well covered, the loss by radiation in the coldest weather is only 3 per cent.

It might, perhaps, be thought that another mode of storing energy might be found by merely allowing the refuse to collect, and burning when required. This, however, is not only highly objectionable on hygienic grounds, which alone ought to be sufficient to condemn it, but we also very much doubt whether it would be practicable. Very large storage area would be required, the labour of handling would be nearly doubled, the number of cells trebled, and the furnaces would be cold, comparatively, when first started, and require reheating every time they were used. Thus it might be expected that working expenses would increase and efficiency diminish. A capital illustration of the influence of the thermic capacity of the massive brickwork structure usually composing the cells is provided by the weekly chart showing temperatures of gases escaping from one cell. The particular cells are comparatively old-fashioned, and therefore the temperatures cannot be taken as indicative of possible results with modern appliances. On Monday morning, when the fires are restarted after having been banked up on Sunday, the temperature in each flue is but little over 700deg. F. A gradual rise goes on during the week until a maximum of 2,200deg. F. is reached on Friday, and then, probably owing to the delivery of a poorer quality of refuse, there is a slight fall until closing time on Saturday. The slight but well defined fall in temperature on Tuesday afternoon and night is due to the vegetable collection after a market day. Another experiment confirms these conclusions, and is also illustrative of the different calorific values of summer and winter refuse. The temperatures were in this instance taken in the main flue of the same destructor as the previous one.



Weekly Chart, showing Temperatures in Main Flue.

Although certain schemes that have recently been suggested for screening and burning do not come strictly under the heading of destructors, yet some experiments that have been made in this direction are instructive, inasmuch as they afford us the means of obtaining the calorific value of dried and screened refuse. According to Messrs. Rawson and Smithson, who tried three tons of Ravensthorpe refuse in this way, 1lb. of the dried combustible portion evaporated 3·23lb. of water (gross) when burned under a Lancashire boiler. This figure, of course, does not represent the available or net steam that could be applied to external motive-power purposes, but it affords us an idea of what the calorific value of the dry combustible portion really is. Thus, in some earlier calculations we assumed that the dry combustible portion was as good as coal, but apparently Ravensthorpe dry combustible refuse is only about one-third as good. Substituting this calorific value for the one we previously took (=coal) we see that 1lb. of unprepared refuse containing 25 per cent. moisture, 25 per cent. incombustible will only evaporate ¼lb. water. This is, of course, a very low evaporative value, and we can only assume



Weekly Chart, showing Temperature of Gases Escaping from One Cell. Each Vertical Division represents 100deg. Fahr.

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that the experiments of Messrs. Rawson and Smithson were exceptional, for very much better results have been obtained elsewhere in actual practice. Had schemes of this nature been suggested 25 years ago we should have expected a future for them, seeing that in those days not only were there no true destructors, but there was far less difficulty in getting rid of the portions that were screened from the refuse prior to burning for manurial purposes, and, also, the public were not then so sensitive as to smells and dust.

It may have been noticed that throughout but few figures have been referred to. These have been avoided for several reasons. Firstly, because the avowed objects have been only the consideration of the principles apparently underlying the destruction of refuse, and of the great difficulties attending the acquisition of complete and accurate information concerning the working of destructors; secondly, the figures which are of greatest interest—namely, those which enable us to arrive at the maximum temperatures and power attainable—have never, so far as we are aware, been experimentally determined, with adequate appliances, continuously over any resonable period; thirdly, the average results, which have recently been quoted so freely in nearly every technical journal of the day, impart no new information to genuine students of the problem, being actually but a repetition of the facts with which they have been acquainted for years past; lastly, these figures, such as they are, cannot be comparable, and tell us nothing, since in no cases do they represent anything more than some unknown fraction of the possible limits of power accessible, and under conditions which are completely at variance one with another. Truly, to quote the apt expressions of a recent speaker on the subject, our knowledge of these matters is in a chaotic state.

If, as appears conceivable, the combustion of refuse becomes in the near future the source of a vast store of a hitherto undreamt of energy, it is almost impossible to see to what climax it will lead. The husbandry of the masses may eventually turn out to be extravagance, and the wastefulness of the wealthy economy to the commonwealth—a possible parodox if it be found that the lingering embers of the domestic hearth can be more efficiently utilised by combustion in a destructor for generating cheap electricity to the relief of local taxation. These suggestions may also provide food for reflection to those who create the refuse, for they will have seen how their personal habits or occupation, their extravagance or their economy, their wealth or poverty are all strikingly reflected in the contents of the despised dustbin.

I have described first how mechanical engineers rely upon the experiments made in laboratories in order that their machines may be properly proportioned; next, how they rely upon the physicist to furnish them with information concerning thermo-dynamics in order that he may deal with heat-engines, and on the mathematician that he may estimate the extent and limits of the forces which he is directing. I have, lastly, given some interesting examples of the value of electrical knowledge in engineering research work. But the converse of each of these propositions is also true; for the physicist, mathematician, laboratory man, each and all in turn, avails himself of the experience and knowledge of the engineer to deal with the difficulties of his own case. *A priori*, this analogy by itself would be sufficient to lead one to believe that the electrician would also profit by such an association, and, as a matter of fact, the relationship is even closer. The electric engine, to be successful, must be designed by a combination of the mechanical engineer and the electrician, just as the ordinary steam-engine requires the assistance of the physicist and engineer. How would the expert in thermo dynamics who knows nothing of the laws of mechanics or strength of materials deal with solid iron and steel? This problem has been long recognised, and deals with the training of mechanical engineers; but such is not the case with the electrical engineer. Until quite recently the student worked at electricity and a little pure mathematics, was dubbed engineer, and cast on the world. So great has been the failure of such men, that Lord Kelvin is reported once to have said, that if the mechanical engineer increased his knowledge 10 per cent. by learning the rudiments of electricity he would become at a bound the electrical engineer of the day. Although this may have been true at the time that he put the remark forward, it can, I hope, no longer be said of the younger generation; for in all the larger schools time is devoted in almost equal amounts to the two branches of engineering, and the combination only is recognised as of service to the client of the electrical engineer.

THE USES OF ACCUMULATORS.

The following is the discussion which took place on May 13 on Mr. Howell's paper read before the Northern Society of Electrical Engineers.

Mr. Edmunds (president) said he was sure that they had all listened with very great interest to Mr. Howell's paper. The question of storage batteries and their uses was one which had forced itself before the mind of every engineer who had had anything to do with electric light supply. The great trouble, he thought, was to find the perfect accumulator. They all understood the great difficulties in the way of direct supply, and the need of some reservoir of electricity. Mr. Howell had read his paper clearly and well. He had not told them in what dark vault he had found his mystic scroll, but whatever cunning scribe had written that leaden document it certainly gave a good history of what had happened in the past, and he thought it also contained something prophetic as to what might happen in the future.

Mr. Wordingham said he thought it was extremely difficult to discuss a paper which introduced a good deal of controversial matter without first going into it, and in consequence of that he could only make a very few remarks. Mr. Howell's paper was not only most humorously and interestingly written, but it bristled with what he (Mr. Wordingham) believed to be facts. He thought, looking at it broadly, that it would be very difficult to assail Mr. Howell's position. To his mind, there was no doubt that storage to a certain extent was essential to the economical working of a station. In that city they had put down a very large battery of 400 h.p. for 2½ hours. This they had put within a mile of the station for the double purpose of effecting the economy Mr. Howell had spoken of, and to save putting down more conductors. He hoped they would introduce considerable economy by the use of the accumulator. One thing always occurred in dealing with these secondary batteries—they were useful for a light load, and so useful at a full load, that the difficulty was to know when to charge them. He agreed with many of Mr. Howell's remarks, and thought he (Mr. Howell) had put the whole case most admirably.

Mr. Rider said that while he thoroughly agreed with Mr. Howell on most of the points raised, so far as they concerned the generating station, he could hardly at that stage enter into the reasons why a high-tension system could still be of service, because they must take into account the distribution as well as the generation. Not like most men who put down high-tension stations, he had such faith in accumulators that he put them down wherever he could find a use for them, such as for exciting the alternators, the alternator being at the time always dependent upon its exciter. He put in accumulators because he knew they could be trusted when wanted to take up the exciting current. His experience of cells was that the Crompton-Howell cells were very good; they had the fault, however, which, he thought, all cells had, that although one could take a very high discharge from them for a short time, they could not be discharged at a high rate; that, he thought, was a point which some makers would do well to look at in the future. If the cells were discharged at a high rate, they should be charged at a high rate. Although the makers would guarantee them, and enter into a contract for the maintenance of these cells, he thought they would find that when the cells were at their best they were in another way at their worst. These were the chief points he had to speak about.

Mr. Clirehugh said he was very much in the same position as the two previous speakers, especially Mr. Rider; the paper, he thought, deserved to be discussed very much more fully than he thought any of them would be prepared to do then, as it was absolutely impossible to take notes of any length and follow what was going on at the same time. Mr. Howell had alarmed them very much by using the Kennedy table of coal consumption, but he did not think he (Mr. Howell) meant it to represent the actual working of a central station; they would see, by referring to the two tables, that when he had consumed 13·2lb. of coal per unit he had reduced his engine to 20 per cent., therefore the difference of 13lb. of coal as against the six would, he thought, never be sustained in practice. As regarded the load-curves, they were excessively interesting and, he had no doubt, accurate in a very great many cases. As regarded the £7,000 spent on the battery, Mr. Howell had allowed 10 per cent. per annum depreciation, but the question was, how long would the battery last? It struck him that 10 per cent., although a reasonable rate of depreciation in one way, was not satisfactory in another, because at the end of 10 years had they got the battery or had they to put down another £7,000? Regarding electric railways, he would like to know which had adopted the accumulators.

Mr. Corlett said he did not think he had any interesting remarks to make on the subject. He could answer Mr. Clirehugh's last question—that one electric railway which had used batteries

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extensively was the Douglas and Laxey Railway, Isle of Man; he believed they ran the whole of their week-end service by means of batteries.

Mr. Fawcus said it had given him great pleasure to listen to Mr. Howell's most able paper, although personally he could not agree with much that he had said. The saving of £13 a day in coal looked very nice on paper, but he was disposed to doubt its accuracy. Still, he was exceedingly glad that they were going to have the opportunity of discussing the paper. It was almost impossible for anyone of them that night who had merely listened to the paper without having any opportunity of studying the figures to discuss the matter properly. If they had time for reflection, perhaps some of them would be able to put Mr. Howell right. Mr. Howell might have given them some little information as to the actual results in pounds of coal consumed per unit in the most modern battery stations. If such a large saving could be effected by the use of accumulators, why was it they saw an alternate-current high-tension station beating the figures of all continuous-current stations?

Discussion, May 27.

Mr. Cowan said that at the last meeting he felt anxious to check Mr. Howell's claim of a saving of £13 per day in coal by using accumulators in the American station, of which diagrams were before them. Since then he had gone carefully into the matter, and could not see that such a saving, or anything like it, was possible with so small a battery. The only way in which economy could be realised by the use of a battery was by storing electrical energy when it cost little to generate, and taking it out for the circuits when its generation first hand would be expensive. It therefore followed that the only saving which could be effected must be made upon the electrical energy which passed through the battery. How was a saving of £13 per day to be made by the use of a battery which only dealt with £5 or £6 worth of electricity, taking its fuel cost at 1d. per unit? He thought that under the conditions of load at the American station 1d. per unit for coal was an ample allowance. It might be claimed that a saving would be effected on the whole output of the station, as the load-factor of the engines was raised to 100 per cent., but a little consideration would show that that was a fallacy. The only further saving which could be made would be due to the better management of the plant on account of the reserve allowing of its better manipulation, but that was a small matter. It seemed to him that Mr. Howell obtained his result by comparing an actual diagram taken from practice with an ideal diagram where everything was done in a perfect way. If they looked carefully at the actual load diagram, they would see that it was peculiar in many respects. The "in-and-out running" of the engine load line suggested that the man who was jockeying that plant had heavily backed accumulators. Mr. Howell said that the engines were run as nearly at full load as was considered safe in American practice, but they ought to be run, not only at full load, but above full load. A steam dynamo which could not be run, at any rate for limited periods, 10 to 20 per cent. in excess of its full load—that is, load of maximum economy—was not fit for an electricity supply station. If, instead of spending £7,000 on a battery, they engaged the services of an engineer who understood better the principles of the economical management of an electricity supply station, they might effect an equal saving without the heavy charge to which a battery was subject.

Mr. Rider said he was very glad indeed that the paper dealt with the uses of accumulators alone, and did not deal with alternating and continuous currents. He believed that cells were a good thing to have in a station, for the reasons Mr. Howell had stated in his paper, for bringing up the engine load-factor to 100 per cent., and because the shifts could be reduced at a certain part of the day. He did not see that there was very much in the use of accumulators as a stand-by against breakdowns, because if the station was properly arranged he would as soon have a good engine and alternator to fall back upon as a set of cells. He thought that to attempt to deal with some towns and some districts with a low-tension direct station would, as the papers said, "take them all their time." Cells could be as readily used in an alternating-current station as in a direct-current station, and if the advantages were so great they could get them just as readily in an alternating station. Let the day-load alternator be fitted with a rectifier, and transform down to 150 volts or so much power as was not being used for the circuits. Send this transformed current through the rectifier and charge a set of cells. The engine load-factor could thus be brought to 100 per cent. throughout the day, and the cells could be used to run a motor-alternator whenever desired, and particularly after midnight and on Sundays. The whole steam plant could be shut down on those occasions. Although accumulators would enable them to do many good things, they would have to be very much improved before they would be highly satisfactory, because, as he remarked at the last meeting, cells could not be charged at a high rate, but it would take from eight to ten hours to fill them again; that was one of the points he thought the makers would have to alter before the cells would be of any great service.

Mr. Crompton said he was very glad to meet the society that evening. Mr. Edmunds had caught him, and he was very glad he had been caught, for two or three reasons. First, he believed he was addressing a meeting of young men all of whom were in charge of work or closely connected with electricity. He was sorry to say that in the old institution, which he had the honour to represent, they had far too much the case of a meeting consisting either of a number of students or teachers who had not yet had any practical experience of the business, and men who had all their own logs to roll. They sometimes got meetings that were not as practical as he would wish. He had read the discussions of the Northern Society, and they had appeared to him to be very much the sort of thing that he had often wished had been the case in his institution. He had read Mr. Howell's paper, and he thoroughly agreed with him in the remark he made on the subject, that the men above all others who they wished to hear speak were men in charge of the stations. He would rather not enter into much disputable matter, because, as they knew, he was said to be a strong partisan of the low tension and also it was known that he had business relations with Mr. Howell; therefore, he would rather let Mr. Howell fight his own battles, but he would like to state a few facts which he thought might prove useful to the society. It had been said that he was what was called a low-tension man; he was not a low-tension man at all, but he was most strongly an anti-alternator current man. Alternating currents were no doubt a splendid thing in their way to professors and schoolboys, but nasty things to deal with in central stations. One of the principal reasons why they were so nasty to deal with, was that they did not allow accumulators to be easily used. Mr. Howell had converted him to the use of accumulators, and the way he did it was to show him (Mr. Crompton) that he would be able to work without that anxiety and worry which attended all central-station work. Mr. Howell had said something about it in his paper, but perhaps he (Mr. Howell) had not dealt with it to its fullest extent. Mr. Howell had also mentioned in his paper about the wear and tear; that was perfectly true—the wear and tear of stations when there was a large number of different dodges for alternating arc lamps, etc.; then came a period which was no joke for the engineer in charge, and so far it had had the result of breeding a race of engineers of whom every Englishman might be proud. He had spent a lot of time travelling, seeing what other people did, and he had had the reverse thing played on him during the last few days. He had had one of the leading engineers from a big continental firm sent over to him to be shown round, and he had to be civil to him and tell him all he knew. The engineer had been examining him for eight days and he (Mr. Crompton) had been examining the engineer; between the two he thought it had proved a mutual benefit. This only showed what a lot they could learn from one another. It was perfectly true that accumulators did waste a certain amount of energy, but it was certainly not more than 15 per cent., and in some cases less. There was such a large saving by the better loading of the engines, and that was where the big saving took place. The difference between having engines loaded to about 50 per cent. and to about 90 per cent. was very large indeed. As regards the objections to Mr. Howell's arguments, very much the same words had been used four years ago as had been used that night; but he could only repeat that when they had tried the work would they believe how much easier, how much cheaper, and how much more satisfactory it was in every way. He had got an alternating station of his own at Chelmsford, and he had tried for two or three years to scheme in a few things to increase their income; one was the use of motors. He would only say that if any man would show him how he could drive four or five printing offices with motors without interfering with the lighting, he would make that gentleman a present of £50 to-morrow; and if they could show him how to use accumulators so that he could make money by them between his generating plant and his network, instead of between his network and the consumers, he would also be glad to hand over another cheque for £50.

Mr. Heaketh said he felt some difficulty in approaching a subject that had been so ably handled by the previous speaker, but he thought if he took it from another point of view he might perhaps be safe from being charged with using stock arguments. He had heard it claimed by advocates of batteries that the ideal use of electricity was that given to gas—that was to say, to store it up to be used just as it was wanted. He was aware that the argument was very far-fetched, and that it never was intended to accumulate all the supply, as in gasworks, but an analogy taken from this view might be instructive. Say they had an accumulator with a capacity of 14,000 ampere-hours. It would cost £7,000—that was to say, assuming 3½ watts per candle-power, they had for £7,000 a storage equal to 400,000 candle-power hours. For the same number of candle-power hours a gasholder cost £1,500. There was rather a wide difference between those two figures, and if they were to adopt very extensively any system of storage they must have something lower than the present capital cost of accumulators. He would like, if it was not asking too much, to have some typical cases given where the cost of coal could be given for the units that were taken out of the battery. As to the point mentioned by Mr. Cowan, of overloading plant, he would not like to be in charge of a station where they could not overload to at least 20 per cent., because if a portion of the plant broke down they must be able to overload at least that extent.

Mr. Clirehugh said he did not intend to say much that evening, as he had been away. They all of them, he thought, speaking for the society, considered it a very great honour that Mr. Crompton had come down that night to favour them with his views on the subject. He was not going to criticise the paper, but the point that occurred to him was this—the danger of a very able paper like the one before them falling into the hands of local authorities. It was a most extraordinary thing how the town clerks and such like people got hold of the wrong end of the stick. Speaking for the whole paper, he maintained that Mr. Howell had simply taken into consideration the fact that the people were going to fetch their electricity, but they must remember those were not the circumstances. They had got to supply electricity to the place where it was paid for. If Mr. Howell could show them the means of getting the electricity there, and still maintain the saving of £13 a day in coal, it was no doubt a really good thing.

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Mr. Fawcus said that after the very strong condemnation of the use of the alternate current by Mr. Crompton, he felt some reply ought to be made. Although he was not a rabid supporter of any particular system, he desired to see the two fairly compared. He had taken out roughly the results obtained by the six commercially best low-tension stations, and the six commercially best high-tension stations as given in published returns, and the low-tension stations had the advantage in cost of production at present. It so happened that three of each kind were managed by corporations and three by companies. The six low-tension were Burnley, Brighton, St. James, Westminster, and Liverpool, and the six high-tension stations Newcastle, Newcastle and District, Hanley, Leeds, Huddersfield, and Portsmouth. The cost of production in the low-tension stations was 1·78d. per unit and in the high-tension stations 1·93d., being a saving in favour of low-tension stations of 7 per cent. in cost of production only; but that cost of production only meant about half the total cost of the current, so that the saving fell down to 3½ per cent. on the total cost. Again, the low-tension stations paid £120 per kilowatt for their plant, while the high-tension stations paid £80—that was to say, the low-tension stations, to obtain the saving, paid 50 per cent. more for their plant than the high-tension; also this comparison was very favourable towards the low-tension stations for another reason—the average time of running was four years, while the average time the high-tension station had been run was two years. Again, the districts that were being served in the case of the low tension were all congested districts, whilst in the other cases the districts were very much more spread about. He had remarked upon the peculiarity of the peak of the diagram shown of the American station, and suggested to Mr. Howell, that as the heaviest load came on at four o'clock in an afternoon in June, the station was probably in the neighbourhood of the south pole or the diagram was taken during an eclipse. Mr. Howell had, however, assured him this peculiarity was caused by motors running in at four in the afternoon. At all events it was a pity that a more reasonable diagram had not been chosen instead of one which appeared to show the station running under almost impossible conditions. He thought this was the most interesting paper the society had had, and it had provoked a good discussion. He was glad to have Mr. Crompton with them to hear his remarks.

Mr. Mountain said he had hoped to hear accumulators discussed. They were undoubtedly useful for many purposes, but they wanted to hear more as to their efficiency. He could not believe the saving shown by Mr. Howell would be realised. The figures given in the paper appeared very much like the figures representing the profits likely to be obtained according to the prospectus of some gold mining company; very satisfactory because the facts were so scarce it was impossible to check them, but he did not think the saving would be anything like that described, if any at all. He thought Mr. Crompton did not apparently appreciate the position of electric supply undertakings in provincial towns. The fact mentioned by Mr. Fawcus was of great importance in considering the relative values of each method of supply. The area of supply must come very largely into the question. Taking Huddersfield as an example, he stated that some houses taking a supply of electrical energy were as much as 3¾ miles from the supply station, and these houses were actually the best consumers, taking more energy than the largest buildings in the central portion of the town, owing to the fact they were burning their lights nearly all the night through, and he could not see how a provincial town was to be thoroughly covered with a network of low-tension mains, owing to the enormous amount of money required, although for congested districts they might do very well indeed.

Mr. Edmunds (president) said he thought Mr. Howell had given them a very good and interesting paper, and Mr. Howell had spoken very guardedly upon all debatable points. He congratulated him upon the modesty he had shown in not making references either to his own or to any particular accumulator, but had drawn the attention of the society as a whole to the valuable aid and help that central stations might receive through their employment. He noted Mr. Crompton's remarks about not mixing different kinds of current; that it was desirable to have one kind, and that direct, not alternating; but that it was not a question of limiting the direct to any particular pressure. Mr. Edmunds further remarked that all lamps ultimately took the same pressure (100 volts), so to speak, but the question as to what pressures should be employed or what kind of current, alternating or direct, between the station and the consumer, was one to be settled by local conditions, such as distance and quantity to be supplied. Mr. Mordey had once said to him that the beauty of an alternating current was that it would not charge an accumulator. He asked him if he were still of that opinion on seeing him one day after reading the paper. Mr. Mordey's reply was: "Show me a good accumulator: a really good one, and probably I shall alter my opinion." Mr. Edmunds thought it was a good accumulator that was wanted. If, instead of the loss now accruing owing to chemical changes, we had something more analogous to a gasholder or water reservoir, then there could be no doubt as to the advantages of the use of accumulators in connection with central stations. He also remarked that they could hardly expect to get the whole of the information regarding accumulators—their *pros* and *cons*.—from one gentleman who only represented one particular kind, and he regretted there were not others present to advocate and discuss the relative merits of other forms of secondary batteries. However, considering the lateness of the evening, he would not take up their time further.

Mr. Howell, replying, said he thanked them very much for the kind way in which they had received his paper, and for the critiques they had passed upon it. Dealing with this criticism, he would take first of all the remarks which Mr. Cowan had made, since they showed he had been at some pains to work out the load curves and the figures upon which the economies to be effected by the use of accumulators had been based. Mr. Cowan had, however, unfortunately fallen into serious error in considering that the saving in coal would only be effected on the number of units stored by the accumulators. On the contrary, the saving was made on every unit generated, since the efficiency of the station as a whole was raised. As a corroboration of the saving of the 13 tons mentioned in the paper, it was only necessary to refer to the Kennedy table, where the pounds of coal per unit for the day's output was 7·33, and for the period of maximum load, when the engines would be running at higher efficiency, 6·1, or almost the exact ratio given for the station mentioned in the paper—80 tons without accumulators, 67 with. Mr. Cowan would thus see that his apparent generosity in giving the coal required to charge the battery was entirely misplaced, and, paradoxical as it might seem to him, the station required less coal for a greater number of units generated, when fitted with accumulators, than it would need for a small number of units generated without accumulators. With regard to Mr. Rider's remarks on accumulators and their use in alternating-current stations, there could be no question that the engineer in charge was considerably relieved by having in his exciting circuit a reserve such as an accumulator would give, and extension would probably take place in the way that Mr. Rider had suggested; in fact, the scroll had more than hinted that shortly after accumulators had been employed in alternating-current stations they were used for driving motor-alternators for the period of light load, and the time over which this light load extended was greatly lengthened by increasing the size of the accumulators, so that they could be charged at the period of heavier load, so as to make the plant run at the higher efficiency. This process was carried on to such an extent that finally the alternating-current station became a low-pressure continuous-current motor alternating station, and, strange to say, with marked economy. Mr. Hesketh's demand for figures as to efficiency was somewhat amusing. What need of enquiring too closely into the efficiency of the batttry when, inefficient as it was, it effected a saving in a station using 80 tons of coal of £4,300 a year? Mr. Hesketh, however, might take it that the energy efficiency over 12 months' running would not be less than 85·6 if the batteries were properly worked, and this figure had been attained in actual practice at one of the Westminster stations under Prof. Kennedy's charge. Accumulators were frequently overcharged, and it was not the fault of the accumulator manufacturers that the efficiencies obtained were frequently so low. Mr. Fawcus had brought an interesting list of stations, which he had, however, omitted to name, comparing the results of low-tension and high-pressure alternating systems, but he had omitted to mention that the periods of service in some of these stations are entirely different. Portsmouth, which was one of the stations named, did not give a constant service, hence its figures were of no earthly value at all. Any station could generate current at period of maximum load and pay. It was the period of minimum load that made electric lighting in some cases difficult from a commercial standpoint, and it was this period of minimum load that accumulators took care of.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

DUBLIN TRAMWAYS.

SIR,—Mr. Owen acknowledges that he is in want of facts. This I suppose is the reason his first letter was so sadly deficient in that respect. If he had not suggested that he held a brief for the views and would-be requirements of all the various local authorities in this country, I should not take the trouble to test the value of his "certain knowledge." When I asked for Mr. Owen's identity, I did not do so, as he appears to think, for the purpose of passing the slightest reflection on his experience in the electric traction field; my object was to find out whether his championship of "Dickinson's system" was quite a disinterested one.

I thought I had clearly expressed in my letter that I did not desire to criticise the merits or demerits of any system, and I never gave it as my opinion that there was any loss of efficiency by the adoption of the South Staffordshire system. Not being a proprietor of patent medicines, I do not believe in one kind of pill curing every kind of malady, but think that each case would be more fairly dealt with in the hands of a competent diagnoser.

Mr. Owen in his letter of protest to you says that the adoption of the centre-pole system of lines already laid would, in his opinion, lead to many serious and fatal accidents. In the face of this prophetic utterance and my alleged ignorance of the system, how could I suggest it or anticipate on his part such a speedy retractation!—

Yours, etc.,
STEPHEN SELLON.

June 10, 1895.

(For remainder of Correspondence see page 687.)

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THE TELEPHONE SYSTEMS OF THE CONTINENT.

The publication of Mr. A. R. Bennett's book on this subject ought to do much to dispel the cloud of ignorance and mis-statement that has so long prevented our due appreciation of actual facts. The subject-matter of this book may well be divided into three parts—critical, administrative, and descriptive. The first of these only claims attention here; the others will form the subject-matter of a notice of the book. In his introduction Mr. Bennett is scathingly critical of the manner in which the telephonic business has been and is being conducted in this country. It is quite refreshing to come across a writer who fearlessly and relentlessly exposes the fallacious arguments that have so long held ground. Broadly speaking, our contention from the first as regards telephony has been that it is a species of telegraphy, and as such should be in the hands of the Government; that a telephone should be found in every ordinary house; and that the annual cost should be at the lowest possible rate. In England, however, we have the business run by a private company, or companies, with an inflated capital, inefficient service, high charges, and comparatively few customers. The value of a telephone to a subscriber increases more than in proportion to the number of co-subscribers. Telephony in this country was originally run for speculative and not industrial purposes, and all the energy and efforts of the past few years have failed to shake off the incubus hung round the neck of telephonic administration by the mistakes of the original organisers of the system. The point that Mr. Bennett drives home is that low rates attract subscribers, and will pay. He says that the advocates of low rates in this country have had their arguments met by a point-blank denial, and their opponents have asserted "that the low rates are not inclusive of all charges; that the subscribers have to pay the cost of their lines or instruments, or both, and after connection for any repairs that may be necessary; that foreign telephone companies are not burdened with such payments to the Government as are imposed on the National Telephone Company here," and a number of other excuses, which are fully set out, but which we need not recapitulate. Mr. Bennett has traversed the Continent to examine on the spot the facts of the case, and so far as his examination goes he says: "It will be found that no two nations have solved, or attempted to solve, the problem in exactly the same manner. In some cases the divergencies are wide, but in most, great intelligence, combined with solicitude for the public weal, has been brought to bear, often with the most satisfactory results." As regards that particular point—the rates—this is what our author says: "Full particulars are given of these variations (of rates) under the headings of the several countries, but it may be as well to state definitely here that inclusive rates, covering the supply and maintenance of all wires, instruments, and accessories, of £2. 10s., £2. 15s. 7d., and £3. 6s. 8d. exist in Norway; of £2. 15s. 7d. and £3. 6s. 8d. in Denmark; of £2. 9s. 7d. and £2. 17s. 10d. in Holland;

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of £3. 4s. in Finland, and of £2. 16s. and £3. 12s. in Italy, while rates of £4 and £5 are of frequent occurrence elsewhere." A categoric denial is also given that low rates mean bad workmanship, and with regard to governmental or similar payments, it is stated "that many foreign companies are burdened with far more onerous payments to their governments or municipal authorities than is the National Telephone Company. In Madrid 20 per cent., in Bilbao 34 per cent., in Barcelona 33·75 per cent., and in Valencia 31·5 per cent. of the gross receipts are payable to the Government. In Italy, a uniform tax of 10 per cent. on the gross receipts and £2 per annum for every public telephone station (call office) is levied; in Russia, the tax is also 10 per cent. of the gross takings, while the Portuguese get off with 3 per cent."

These extracts, which are statements of facts, will once for all disprove the general statements and denials that have hitherto been so freely used, and the author states emphatically "that an exchange with metallic circuits, underground wires in the centre of the town to each block of buildings, and all modern improvements, could readily be made remunerative at £5 per annum, Post Office royalty included." The fact of it is that this introduction of Mr. Bennett consists of a mass of admirable fighting material, bearing upon its face the stamp of authenticity, and which not only the technical, but the general Press of this country should circulate as widely as possible. It is shown that official answers to parliamentary questions are woefully defective in accuracy, and it may be assumed that the truth of the matter has never before been placed before the public. The more these facts are considered, the more striking must be the conclusion that the cheapest, best, and most efficient form of telephone control is as a branch of the Government Telegraph Department. Then the work would be carried out systematically and not by piecework, so that as exchange was added to exchange and town to town, the benefit of cheap telephony would be more and more appreciated, to the advantage of the revenue.

THE CHELMSFORD ACCOUNTS.

We have received a copy of these accounts as presented to the Board of Trade. These accounts cannot be deemed very satisfactory, but it seems that the fault is in the charge made for public lighting being too low. The cost of electric energy delivered on to the mains is 2d. per unit, and the generation of 156,184 units so generated is £1,301. 10s. 8d. The selling price to private consumers is 6½d. per unit, and the net revenue derived from this source is £992. 6s. 8d. Now, the cost per unit is not the cost of generation, but this plus administration expenses, which bring the total cost to £1,953. 16s. 9d., or a cost per unit, say, of 3d. So far as the private lighting is concerned there is evidently a good profit, therefore a loss must come from the public lighting; for the total profit is only £210. 16s. 3d., a considerably less profit than is obtained from the private lighting alone. It seems to us that the public lighting, to be produced at cost price, ought to bring in about £1,500, instead of £969. 18s. 10d. Practically the accounts show a capital expenditure of £17,253. 16s. 6d., a revenue for the year of £2,164. 13s., with an expenditure of £1,953. 16s. 9d., leaving a profit of £210. 16s. 3d., with which to pay interest. The extension of private lighting will, no doubt, continue, and bring about a more favourable balance but we again say that in our opinion the public lighting is done at too low a figure.

COST OF PRIVATE LIGHTING.

The question of the cases in which it is advantageous for a consumer to lay down plant to generate his own electricity is a most interesting subject. A test of a private plant at Newcastle-on-Tyne by Mr. T. Hanning appears in another column, and is of great interest as an addition to the facts about private electric lighting plants. We are not sure whether the engineer making the test or the contractor made the deductions as to the annual cost, but we must protest against the use of figures obtained from special trials being used without extra allowances in the estimates as to annual cost. The results thus obtained, combined with the low labour charges and no allowance for repairs item, do certainly give an unduly favourable result for this small plant. In spite of this, we do not doubt but that the users will find their annual cost come out considerably under what they would have to pay to the supply company for the same light.

CITY AND GUILDS EXAMINATIONS.

SIR,—Reverting to your published "Answers and Solutions" of the 1894 Preliminary Examination of the City and Guilds of London Institute (see *Electrical Engineer*, April 19, 1895, page 452, col. 2).

Query 4.—A lamp circuit is supplied at a pressure of 100 volts. There are 42 lamps all in "parallel," and the resistance of each lamp (when hot) is 150 ohms. How much current will the circuit take when all the lamps are on? *Answer.*—28 amperes.

I am at a loss to understand this, as by Ohm's law $C = \frac{E}{R}$ = amperage. Now, here the E is a minus quantity by one-third, showing that the amperage is above $\frac{66}{100}$, or 0·66. Now, the lamps are in "parallel"; but the working of the answer seems to be done by multiplying the volts by the lamps—*i.e.*,

100 volts
42 lamps

total 4,200 volts ÷ 150 ohms

(*one* lamp's resistance); and, of course, gives just 28. What?

Now, if all the 42 lamps were in "series," the total resistance of the lamps would be 6,300 ohms requiring 6,300 volts for 1 ampere of current, and such a current would maintain a 32-c.p. 105-volt Edison-Swan lamp.

Suppose you take an example of the above, and say 100 volts by 28 amperes gives 2,800 watts; 2,800 watts ÷ 746 give close upon 4 h.p. (or 3·+$\frac{592}{746}$ths. Now, allowing three watts per candle-power, we have 933 c.p., or 58 16 c.p. + 5 c.p. The answer shows an incomplete working according to actual practice, or the problem may be abstruse, and if so shows a certain futility of purpose.

Now, if we divide the resistance 150 ohms by 42, the number of lamps, we have $\frac{15·0}{4·2}$ = 30·24 ohms for each lamp; and if we multiply the 100 volts by the 30·24 ohms resistance we have 3,010·3 watts, showing 4 h.p. + 26 watts.

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Therefore that is not the working out of the problem. But if we divide our 100 volts by the 30·24, or, say, 31 ohms resistance, we have $\frac{E}{R} = \frac{100}{31} = \div 100$ by $31{\cdot}0 = 3{\cdot}07$ of an ampere; and as a lamp of 150 ohms resistance requires 2·3 amperes for a 50-c.p. lamp at three watts per candle-power, we should be safe at 2·8 amperes of current, being only a 0·5 ampere for margin and for drop of potential at the further lamp on the circuit. Therefore the error may lie in 28 amperes instead of 2·8 amperes.—Yours, etc.,

June 3, 1895. JEAN MUNIER.

[We have thought it best to insert this letter rather than to answer it privately, because an explanation of the matter may help other students. Our correspondent is quite right to stick to Ohm's law; his failure is probably due to little tortuosities in mathematical working, causing sad errors.

One easy way is as follows:

$$C = \frac{E}{R};$$

that is

$$\text{amperes} = \frac{\text{volts}}{\text{ohms}}.$$

Now, the ohms in this case

$$= \frac{\text{resistance of one lamp}}{\text{number of lamps}} = \frac{150}{42},$$

so that we may write, instead of $C = \frac{E}{R}$, $C = \frac{E}{\frac{R}{n}}$,

which is the same as $C = \frac{E \times n}{R}$.

Putting the given figures in the formula as it thus stands, we get

$$C = \frac{100 \times 42}{150} = \frac{2 \times 14}{1} = 28.$$

The answer, therefore, is 28 amperes.—ED. *E. E.*]

ELECTRIC TRAMWAY.

SIR,—Having visited Guernsey to satisfy my curiosity to see an electric tramway system in work, you will be interested to know that I heard nothing but satisfaction expressed by drivers, conductors, riders, and others. The only complaint was that the car rails are in bad condition for want of a better foundation and through wear when previously traversed by steam-engines. The general opinion was that no person noticed the overhead wires now they had got accustomed to them, and they *do not* constitute an eyesore, considering the successful working of the line. The cars travel at very good speed when fully loaded inside and out, and I saw three cars coupled and loaded go along right merrily. The stopping and starting is without jerk. There is very little sound, and complete freedom from the objectionable smells of oil, steam, and smoke given off from steam-engines. Electric traction undoubtedly stands well for a good future.—Yours, etc.,

J. H. HEATHMAN.

P.S.—I must add that the cars are lighted by electric incandescent lamps in a most pleasant way.

THE FARADAY HOUSE STUDENTS' DINNER.

The students' dinner of the Electrical Standardising, Testing, and Training Institution was held at the Imperial Institute on the 6th inst. In the absence, through domestic affliction, of Lord Castletown of Upper Ossory, the chair was taken by Mr. Robert Hammond, and among his supporters were Sir Courtenay Boyle, Mr. H. Kimber, M.P., Earl Russell, Colonel Gouraud, Mr. C. E. Spagnoletti, and Judge Snagge. About 170 guests were entertained by the Board of Control of the above institution, and after an excellent dinner the following toasts were proposed and responded to: "The Queen," proposed by the Chairman. Colonel Gouraud, in an amusing speech, proposed "The Institution." He referred to the old school started, in 1882, on the same lines by Mr. Hammond, which was too soon in the field to receive the requisite support. At that date, Colonel Gouraud had promoted a company with a capital of £1,000,000, of which £200,000 was called up, with the idea of lending money to electrical companies, etc., deserving of support. As no such deserving company or individual was to be found during the first two years, they called a general meeting and returned the money. Still, such times were now passed, and the speaker wished every success to the young men passing through the training course at Faraday House. Mr. R. Hammond responded, and, after describing some of his early experiences in the profession, which he had to work with his own hand for want of skilled assistance, he referred to the present state of the industry, and to the genuine investment of capital now being made in the electrical works of the country. The toast of "The Visitors," proposed by Mr. Francis Ince, was responded to by Judge Snagge, who said that all the relations of this Empire, on which the sun never sets, vibrated over a network of wires, the meshes of which were narrowing every day. The Chairman proposed "Past and Present Students," Mr. H. S. Gladstone, a present student, responding. Sir Courtenay E. Boyle proposed "The Board of Control and Staff," and after referring to the labour of the Board of Trade in connection with electric enterprise, he said that the field of electric energy which lay before them was unlimited. Electricians had conquered the earth and to a great extent the ocean, but was there any reason why motion should be confined to the earth and the water? It was for the young people before him, enthusiastic, learned, and vigorous, to apply their talents and their industry to this great region as yet unexplored. Mr. Harrison, principal of the institution, responded.

THE ABSOLUTE MEASUREMENT OF ELECTRICAL RESISTANCE.*

BY PROF. J. V. JONES, M.A., B.SC., F.R.S.

§ 1. If we take a conductor—such as this piece of copper wire—and make it part of a conducting circuit in which an electric current is flowing, we find that the E.M.F. between its extremities is proportional to the strength of the current passing through it, so long as it remains in the same physical condition. If either the E.M.F. or the current strength varies, the other varies in like proportion. Their ratio is constant—*i.e.*, it has a value independent of them, and depending only on the dimensions of the conductor, the nature of the material of which it is made, the state of aggregation of its parts, and its temperature. This ratio is called the electrical resistance of the conductor, and so defined it corresponds to a real physical quantity—it is a physical property of the conductor.

§ 2. Probably no physical measurement can be made with greater accuracy than the comparison of electrical resistances. Such comparisons are daily made in many parts of the world; and it is clearly desirable, in order that the results obtained by one man may have meaning for others, that all should make their reckoning in terms of the same unit. Accordingly, the scientific world has given great attention to the definition of such a unit, and much international negotiation has taken place with a view of securing world-wide agreement on this point.

The most obvious method of procedure is to fix upon some convenient conductor as a standard, and to call its electrical resistance the unit of electrical resistance, other electrical resistances being then expressed as so many times, or such-and-such a fraction of the resistance of this standard conductor. The disadvantage of this method of defining the unit is that the resistance of such a standard may change from time to time through alterations of its physical condition. The most notable change is consequent on change of temperature. This may, however, be allowed for by defining the unit as the electrical resistance of the standard conductor when it is at a specified temperature. But the other changes of physical condition, changes in the state of aggregation of the parts of the conductor, effects of strain, alterations of molecular structure, etc., are more serious, because they are unknown, and we cannot in our definition provide against unknown possible changes. We run the risk, therefore, of having a varying unit, and the prime requisite of a unit is constancy. In England the Government has taken this risk, and committed itself—at least, for the

* Friday evening discourse delivered at the Royal Institution, May 24, 1895.

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present—to this method of specifying the unit of electrical resistance.

The denomination of the standard of electrical resistance contained in the recent Order in Council regarding standards for electrical measurements is as follows: "A standard of electrical resistance denominated one ohm, being the resistance between the copper terminals of the instrument marked 'Board of Trade Ohm Standard, Verified 1894,' to the passage of an unvarying electrical current when the coil of insulated wire forming part of the aforesaid instrument, and connected to the aforesaid terminals, is in all parts at a temperature of 15° ·4 C." This is a plain adoption of an arbitrary standard. The resistance of a certain piece of wire wound into a coil is made the legal unit, and if this resistance varies our legal unit varies with it. It is true that, in constructing the standard, efforts have been made to ensure that its resistance shall be equal to 1,000 million times the absolute unit of which I shall presently speak, that the standard was in construction based upon the ohm; but there is no provision in the Order in Council for revision if the standard varies, nor, indeed, has the Government any means at its disposal of directly measuring its standard in absolute measure. I seem to be finding fault. That is not my intention. I am only advocating progress. The time is ripe for the adoption of the absolute unit, not merely nominally, but really, for the frank acceptance of the absolute unit itself as the ultimate legal standard.

§ 3. Now, what is an absolute unit? The following considerations affecting physical measurements generally will, I hope, serve to make this clear. In order to specify the magnitude of any physical quantity we bring it into relation with a standard magnitude of the same kind, called the unit, and say that it is so many times or such-and-such a fraction of this unit. Thus we speak of a length of 6cm., a mass of 50 grammes, a time of 20 seconds, an electric current of 10 amperes, an electrical resistance of 30 ohms, and so on. For the purpose of this specification, any convenient magnitude of the physical quantity to be measured may be taken as the unit. But science has to deal with many kinds of quantities, and when we consider the various units as constituting a system our arbitrary choice is limited by two conditions of prime importance:

(i.) The units must be chosen so as to simplify as far as may be the statement of the quantitative relations existing between various kinds of quantities. Physical science, in so far as it is quantitative—may we not say in so far as it is perfected?—tells us of relations of interdependence between many different kinds of quantities. Thus, in geometry we have such relations between lengths, areas, and volumes; in kinematics, relations between these mathematical quantities and times, velocities, and accelerations; in dynamics, between these mathematical and kinematical quantities and mass, momentum, force, work, and energy; in electrical and magnetic science, relations between the foregoing quantities and electrical and magnetic magnitudes; and so on. These relations of interdependence are expressed in equations; and it is of obvious advantage, both for ease of arithmetical calculation and clearness of thought, to rid these equations as far as possible of superfluous arithmetical constants. This may be done by a judicious selection of units, by making the units of the quantities that appear most complex in their relations of interdependence depend upon the units of the quantities that appear in their nature to be simplest. A unit of any quantity so defined with reference to the units of quantities apparently simpler, is called a derived unit with reference to the latter units as fundamental. Thus, the attraction of the earth on a mass of 1lb.—the weight of 1lb.—is an arbitrary unit of force. The force that acting on a mass of 1lb. increases its velocity by 1ft. per second every second, is a derived unit of force with reference to the units of length, time, and mass as fundamental. It is usually called the absolute unit of force in the pound-foot-second system; and by the very nature of its definition it gets rid of an arbitrary constant in the relation between force, mass, and acceleration. If the arbitrary unit of force mentioned above—the gravitation unit—is used instead of the absolute unit, our dynamical equations are uselessly complicated by the introduction of "g," the acceleration of gravity at the particular point of the earth's surface at which we happen to be, and at the particular time when our measurements happen to be made.

(ii.) The second condition of prime importance to a scientific system of units is that the units of all quantities should be invariable, unaffected by conditions of time and place, and independent of the properties of particular bodies—*i.e.*, they should be *absolute*. The word "absolute" is in philosophy opposed to "conditioned." When it is applied to a unit in science, the implication should be that the unit is the same at all times and in all places, and that it is unconditioned by the properties of any specified body or bodies—*i.e.*, that its magnitude is brought into relation with and depends upon only the most permanent phenomena of the universe.

The modern system of absolute units goes far to fulfil the first of our two requirement; it only very partially fulfils the second. When we speak of an absolute unit at present, we mean a unit the magnitude of which depends on nothing else than the units of length, time, and mass, and the properties of the ether. The latter may be regarded as universal enough, but the units of length, mass, and time are arbitrary standards. The metre depends on the properties of a particular bar, the gramme on the properties of a particular piece of platinum, the mean solar second on particular bodies of the solar system.

The time will doubtless come when we shall be able to take another step forward, when we shall be in a position to make the unit of mass a derived unit with reference to the units of length and time as fundamental through that universal uniformity of Nature—the law of gravitation—the units of length and time being based on some more permanent phenomena of the universe (the properties of the sodium molecule have, for instance, been suggested) than the length of a particular bar, the motion of the earth on which we live. But we cannot take this step forward yet. We do not know either the gravitation constant or the velocity of light with sufficient accuracy to enable us to define by means of them units precise enough to meet the needs of practical life. Yet the fact that if we knew these constants, we could make an important advance in the realisation of a system of absolute measurement, is an excellent reason why the masters of physical measurement should apply themselves to their precise determination.

The use of a derived unit of mass would have this, among other advantages, that it would rationatise the dimensions of the electric and magnetic units in length and time, and relegate the irrationality to the ether, to which I believe it properly belongs. We must, however, for the present be content with a less complete reference to the most permanent phenomena of the universe; and by absolute measurement to-night I mean measurement in terms of a unit derived with reference to the units of length, time, and mass as fundamental—*i.e.*, a unit conditioned only by these units, and the properties of the ether.

§ 4. There is such a unit of electrical resistance—a unit derived with reference to the units of length and time as fundamental—the magnitude of which is independent of the properties of any particular conductor, any particular coil of wire, and which is conditioned only by the units of length and time, and the properties of the ether. It may, indeed, at first sight seem astonishing that a quantity so different can be expressed in terms of a length and a time. Yet so it is. We can, in virtue of experiments made 63 years ago in this institution by Michael Faraday, measure the resistance of a conductor with the help of no other standardising instruments than a tape or measuring machine and a clock. An electrical resistance is always proportional to a certain velocity, and if the magnetic permeability of the ether be taken to be unity, the number expressing the electrical resistance will be the same as the number expressing that velocity. The unit of electrical resistance may then be taken to be the resistance corresponding to unit velocity—*i.e.*, on the C.G.S. system, a velocity of 1cm. per second—and any electrical resistance may be conveniently expressed in terms of this unit as so many centimetres per second. You will observe that I do not say electrical resistance *is* a velocity—that would be to neglect the unknown dimensions of the magnetic permeability of the ether. If the unit of length, the unit of time, and the properties of the ether remain constant, this unit of electrical resistance remains constant. It is unconditioned by the properties of any material, by position in space, or point of time, and so far deserves the name of the absolute unit of electrical resistance.

§ 5. How comes it that resistance can be so measured? The answer to this question is best found in a description of some one of the methods by which the measurement of an electrical resistance in terms of the absolute unit can be experimentally made. And I proceed, therefore, to a description of the method which may fairly be described as the simplest, and which, in my opinion, having regard to the magnificent possibilities of mechanical engineering operations in this country, is undoubtedly capable of being made the most accurate of all the methods that have been proposed since the British Association Committee more than 30 years ago propounded the theoretical definition of the absolute unit. The method is due to Lorenz, and Lord Rayleigh, at the conclusion of his masterly determinations of the value of the B.A. coils in absolute measure, expressed himself in regard to it as follows: "On the whole, I am of opinion that if it is desirable at the present time to construct apparatus on the most favourable scale so as to reach the highest attainable accuracy, the modification of Lorenz's method last described is the one that offers the best prospect of success." The paper from which I quote contained a comparison of the various methods of measuring resistance in absolute units, and an invitation to others to join in the work. It was the starting point of my own researches in the matter, which have extended over some years, and I gladly take the opportunity of thanking Lord Rayleigh for this source of inspiration.

§ 6. Faraday discovered that if a conductor is made to move in a magnetic field so as to cut across the flux of magnetic induc-

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tion, the conductor becomes the seat of E.M.F., and that the E.M.F. so developed is proportional to the rate at which the induction flux is traversed. If, for instance, we take a metal disc and make it rotate about a horizontal axis n times a second, any radius of the disc cuts through the earth's induction flux unless the plane of the disc is in the magnetic meridian. There will therefore be E.M.F. between the centre and circumference of the disc. Further, since a radius traverses the whole area of the disc n times in a second, the rate at which the induction flux is being traversed by any radius is n I, where I is the total flux of induction through the disc area. But the E.M.F. is proportional to this rate; therefore we have (with a proper choice of the unit of E.M.F.)

$$E^1 = n\,I,$$

where E^1 is the E.M.F. between the centre and circumference.

But we may, instead of using the earth's field, obtain a magnetic field by means of an electric current. The disc may be made to spin in the magnetic field due to a current in a coil of wire placed so as to be coaxial with it, and so that its middle plane coincides with the plane of the disc. In this case the magnetic field is symmetrical with regard to the common axis, and we have once more

$$E^1 = I\,n,$$

where E^1 is the E.M.F. between the centre and circumference consequent on the rotation of the disc at the rate of n turns per second in the induction flux due to the current in the coil, I being the total amount of that flux which passes through the disc circumference.

§ 7. Now, the current strength in a given circuit is by definition proportional to the intensity of the magnetic field produced by it at any point, and hence the magnetic induction through the disc due to the current in the coil is proportional to the strength of that current. It follows that the magnetic induction through the disc is made up of two factors—viz., the current in the coil, and the magnetic induction that would pass through the disc if unit current passed through the coil. The latter factor is called the coefficient of mutual induction if the coil and disc circumference and its value depends only on their dimensions and relative positions, and the magnetic permeability of the medium in which they are placed. If the latter quantity is taken to be unity, the coefficient of mutual induction is expressible as a length, and it may be calculated from observations involving nothing else than measurement of the radius and breadth of the coil, and the radius of the disc. Let this coefficient of mutual induction be denoted by M, and the current in the coil by γ^1; then

$$I = M\,\gamma^1,$$

and finally

$$E^1 = n\,I = n\,M\,\gamma^1, \text{ or } \frac{E^1}{\gamma^1} = n\,M.$$

§ 8. We have, therefore, two ways of expressing the ratio of an E.M.F. to a current. By definition (Ohm's law) this ratio is given to us as electrical resistance, or

$$\frac{E}{\gamma} = R.$$

By the experiment of the disc and coil it is given to us as the product of their coefficient of mutual induction and the rate of rotation of the disc (number of turns per second). And if the ratio for the disc and coil is made the same as the ratio for the resistance (which it is possible in practice to arrange), we have

$$R = M\,n.$$

If the magnetic permeability of the medium be taken as unity, M is a length expressible as so many centimetres, and the number of turns per second is the reciprocal of the time of one revolution of the disc. Hence the resistance may be expressed as a velocity of M centimetres in the time of one revolution of the disc. This makes it clear that, with the assumption in regard to the permeability of the ether (or air) that we have made above, any electrical resistance is expressible as a velocity of so many centimetres per second.

§ 9. We can in practice make the ratio for disc and coil the same as the ratio for the resistance by first sending the same current through coil and resistance, and then varying the speed of the disc so as to make the E.M.F. between its centre and circumference equal to the E.M.F. between the resistance terminals. How can we test the equality of the two E.M.F.'s? If two equal E.M.F.'s act in opposite directions in the same circuit, the result is electrical equilibrium. We have, therefore, to proceed as follows. Place the two E.M.F.'s in the same circuit so as to act in opposite directions; then if they are the only E.M.F.'s in the circuit, there will be an electric current round the circuit due to their difference if they are unequal, and no electric current at all if they are equal. The presence or absence of a current may be tested by the inclusion of a galvanometer in the circuit.

In practice, it is not quite so simple as this, because it is impossible to make the two E.M.F.'s in question the only E.M.F.'s in the circuit. There will be others, and especially thermo-electric forces, always present. But this difficulty may be met thus: Reverse the two E.M.F.'s we are comparing; if the current in the circuit is not changed by this reversal of both, they must be equal—*i.e.*, if the reading of the galvanometer be the same, whether the balancing E.M.F.'s are in one direction or the other, these E.M.F.'s are equal. The reversal of both our E.M.F.'s may be readily effected in practice by simply reversing the direction of the current through the coil and resistance.

To measure our resistance in absolute measure, we have, then,

(i.) To make the coil, S S S (Fig. 1), and the resistance, X Y, parts of the same main circuit, B C F S S S P X Y Q C B, and to pass through this circuit an electric current. A commutator, C, is to be inserted in the circuit in order that the direction of the current may be changed at will.

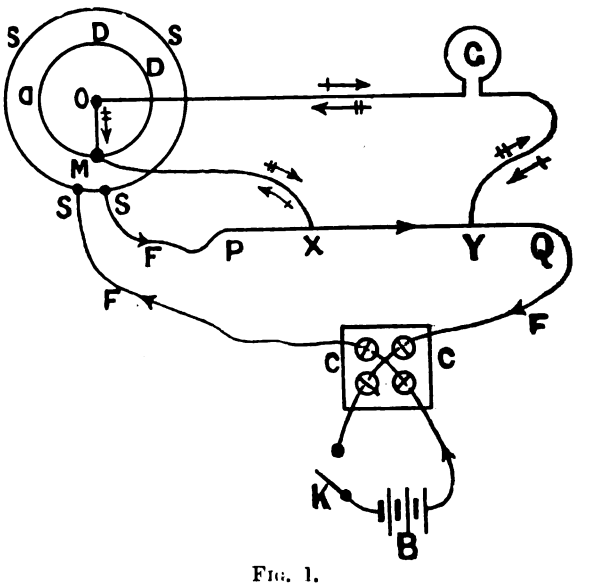

FIG. 1.

(ii.) To insert the E.M.F. between the centre and circumference of the disc, D D D, acting in one direction, and the E.M.F. between the extremities of the resistance acting in the opposite direction in a second circuit, X M O G Y X, containing a sufficiently sensitive galvanometer, G. Brush contacts must be made at O and M.

(iii.) To vary the rate of rotation of the disc until the reading of the galvanometer is the same, whether the current in the main circuit through coil and resistance is being sent by the commutator in one direction or the other.

(iv.) To measure this equilibrium rate of rotation.

(v.) To multiply this equilibrium rate of rotation (number of turns per second) by the coefficient of mutual induction of the coil and disc, which is calculated once for all from their measured dimensions. This product gives the resistance to be measured in absolute units.

[The necessary arrangements were here experimentally shown by the lecturer.]

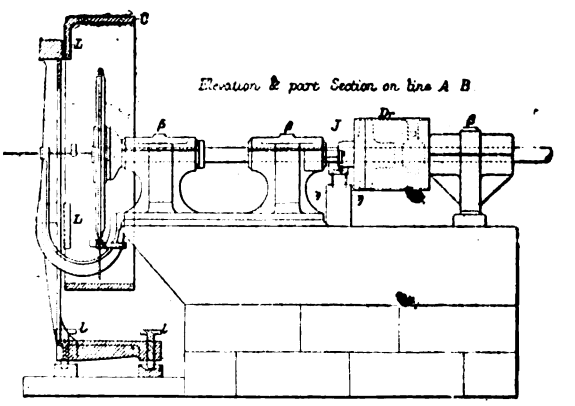

FIG. 2.

§ 10. I trust that I have said sufficient to make clear to you the general theory of the measurement of a resistance in absolute measure by this method. It now remains to consider very briefly the practical side of the matter—the difficulties that arise, the way in which they may be met, and the accuracy attainable. The time at my disposal does not allow me to do this at all completely, and I must content myself with touching on a few points of special importance and interest.

The first great desideratum is that we should have the rate of rotation of the disc well under control, that it should run as

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uniformly as possible, and that its rate should be capable of sufficiently exact determination. The disc, axle, and bearings in my apparatus at Cardiff are of phosphor bronze, Figs. 2 and 3. The disc is insulated from the axle by well-paraffined ebonite, Fig. 4; otherwise there would be short-circuiting of part of its radius through the bearing and bed. It was at first intended to drive the disc by rope gearing from the electromotor. But in the course of preliminary experiments—though the rope was 40 yards long, and joining of the ends took place over a length of at least 6ft.—there was a sudden variation in speed, producing a distinct movement of my galvanometer needle, and visible at the tuning-fork, of which I shall presently speak, whenever the joint passed over the pulley. The rope gearing was therefore abandoned, and the motor coupled direct. The current driving the motor is supplied from secondary cells. It passes to the motor through resistance coils, and may be increased or diminished by throwing some of these coils into or out of the circuit. It may also be varied continuously through a small range by a slide

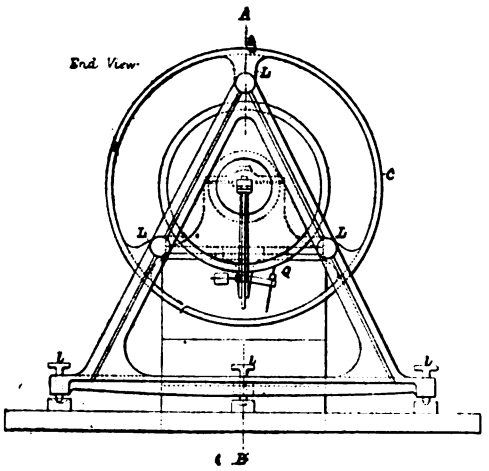

FIG. 3.

resistance of platinoid wire after the larger adjustment has been made. A shunt worked by a lever provides means of taking out or putting in a small resistance suddenly, so as to allow the observer controlling the speed while an observation is being taken, to counteract small variations of speed due to alteration n the lubrications of the bearings and the friction of the brushes

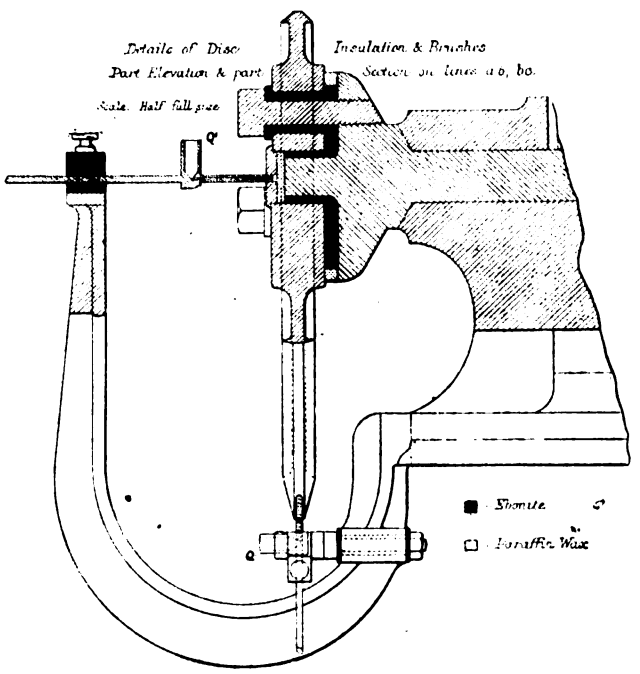

FIG. 4.

on the commutator of the motor. With these arrangements we can obtain any required rate of rotation from about 150 to 1,500 revolutions per minute.

It is of the greatest importance, if the observations presently to be described are to be made with ease, that the rate of rotation should remain constant for the four or five minutes required, and no effort made to compass such uniformity is thrown away. The design, workmanship, and lubrication of all the bearings require closest attention, and the friction between the brushes and the motor commutator should be reduced to a minimum. In my Cardiff apparatus the axle near the motor bears a heavy flywheel.

During a run the observer controlling the rate of rotation requires some test of uniformity, so that he may, if there is a quickening or slowing down, diminish or increase respectively the current through the electromotor so as to recover the initial speed. To accomplish this, it is convenient to refer the rate of rotation by a stroboscopic method to a suitable tuning-fork provided with riders and maintained in vibration electrically. Here is such a fork. At the end of each prong there is an aluminium plate with a slit in it parallel to the prong. When the fork is in equilibrium the slits are opposite one another, and an observer can see through both. When the fork is in vibration he can see through the slits only when they are opposite one another. This position occurs twice in every complete vibration. Hence, if the number of vibrations per second is, say, 64, he obtains 128 views per second.

Now, let us suppose that he looks through the vibrating slits at a drum or disc coloured black, on which a number of white spaces, which I will call teeth, are painted at equal angular intervals. Here is such a disc attached to the rotating axle, on which there are radial teeth. If the rate of rotation is such that in the interval between two views a tooth in any row exactly takes the place of the next, that row will appear stationary; if it does not quite do so, the row will appear to be moving backward; if it passes beyond, the row will appear to be moving forward. These phenomena I can show you by illuminating the rotating disc by intermittent light. The light of this alternating arc varies in intensity at each alternation, passing from maximum to maximum through a minimum that is, however, very far from darkness. Our speed is such as to make the 14 teeth appear almost stationary in this intermittent light. You can see the teeth, but they stand out somewhat faintly. The faintness is due to the fact that we have not complete darkness between the maxima of illumination.

(To be continued.)

TEST OF PRIVATE LIGHTING PLANT.

The following test of the private electric lighting plant at Olympia, Newcastle-on-Tyne, was taken by Mr. Thos. Hanning, A.M.I.C.E., for the directors of Olympia, Limited, on March 28, 29, and 30, 1895:

ENGINE.

Test.	Indicated horse power.	Brake horse power.	Cubic feet of gas used per hour.	Cubic feet of gas used per I.H.P.	Cubic feet of gas used per B.H.P.	Speed in revs. per minute.	Efficiency B.H.P. / I.H.P.
1	9	—	267	29·6	—	160	—
2	18·5	12	380	20·5	31·6	158	65%
3	25	19	560	22·4	29·5	156	76
4	31	25	660	21·3	26·4	154	80
5	38	32	770	20·26	24·0	—	84

DYNAMO.

Test.	Volts at terminals.	Ampere readings at switchboard.	Speed in revolutions per minute.	Total kilowatts.	Electrical horse-power.	Electrical efficiency.	Combined efficiency. E.H.P. / I.H.P.	Cost of gas per hour.	Cost of gas per kilowatt generated.	Load.
								d.	d.	
1	105	—	1,165	—	—	—	—	5·34	—	Light
2	106	65	1,135	6·89	9·23	—	50%	7·6	1·10	¼
3	106	100	1,105	10·6	14·21	—	56·84%	11·2	1·06	½
4	105	152	1,110	15·96	21·39	92%	69%	13·2	·825	Full
5	—	—	—	—	—	—	—	—	—	Brake

Watts per I.H.P. full load = 514·84. Watts per B.H.P. full load = 638·4. Gas at 1s. 8d. per 1,000 cubic feet.

Extracts from Engineer's Report.

"The combined plant tested during a five hours' run under varying loads gave very satisfactory results. The dynamo also did its work well, the pressure remaining particularly steady and fairly constant. There was no sparking at the brushes, and at the finish of the test there were no signs of overheating of any of the parts. The electrical efficiency of 92 per cent. places this machine in a good class. The combined efficiency of 69 per cent. is good for this system of generating."

Estimated Annual Cost.

Actual cost of working above plant for one year of 1,000 hours.
Cost of plant, £700.

Interest and depreciation, 10 per cent. on £700	£70	0	0
Oil and waste—52 weeks at 2s. 6d. per week	6	10	0
Cost of 660,000 cubic feet, at 1s. 8d. per 1,000	55	0	0

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Attendant—1,200 hours, at 5d. per hour	25	0	0
Lamp renewals and carbons for three arc lamps	13	10	0
Total cost per annum of 1,000 hours	£170	0	0

Total cost per unit generated, 2·55d.

	Pence.
Total cost of gas per unit generated	·825
,, interest and depreciation per unit generated...	1 05
,, labour ,, ...	·375
,, lamp renewals and carbons ,, ..	·202
,, oil and waste ,, ...	·097
	2·550

Total cost per 16-c p. lamp per hour = ·127 of a penny.
Candle-power per cubic foot of gas used = 8.

The above plant consists of a 38-i.h.p. gas-engine and a 16-kilowatt dynamo, and was not fitted up with a view of making a show, but may be taken as a sample of our ordinary work.

It will be noted that there is a surplus of power in the engine over and above that required to drive the dynamo at full load, also that there is a difference in the efficiency of 4 per cent. between dynamo load and full load. If the engine was more nearly proportional to the work to be done by the dynamo, this 4 per cent. difference would go towards improving the efficiency of the combined plant, although we believe a surplus of power in a gas-engine to be a fault on the right side. This plant was supplied and installed by Rowland Barnett and Co., Limited, of Newcastle-on-Tyne.

LEGAL INTELLIGENCE.

SHELFER v. THE CITY OF LONDON ELECTRIC LIGHTING COMPANY—MEUX'S BREWERY COMPANY v. THE SAME.

In these two actions the Court of Appeal on December 18 last granted an injunction to restrain the defendant company from carrying on their works so as to occasion a nuisance to either of the plaintiffs. The plaintiff Shelfer is the tenant of a public-house, called the Waterman's Arms, at Bankside, Southwark, of which Meux's Brewery Company are the landlords The defendant company's works are in the immediate neighbourhood of the public-house. The nuisance complained of by the plaintiffs consisted mainly in vibration caused by the defendants' engines. The Court granted a suspension of the operation of the injunction for a period of six months to enable the defendants to decide whether they would appeal to the House of Lords. They decided to appeal, but subsequently they changed their manager, and they have appointed Mr. Frank Bailey, an experienced electrical engineer, to be their manager. Mr. Bailey has advised the defendants that it is possible to stop the vibration, and thus enable them to carry on their works without causing a nuisance. This being so, it would be useless to appeal and the defendants have withdrawn their appeal and definitely abandoned it. Mr. Bailey proposes to remove four vertical engines of the defendants, and to substitute four steam turbines, which, it is said, will produce no vibration. Some temporary mode of carrying on the works will be adopted while the alteration is being made.

Mr. Moulton, Q.C. (with whom were Mr. Renshaw, Q.C., and Mr. W. C. Braithwaite), for the defendants, applied on Wednesday for an extension of the period of suspension of the injunction until the Hilary sittings next year, to enable the defendants to make the proposed alterations. The turbines could not be obtained until next October. They are only manufactured by one firm.

Mr. Warmington, Q.C. (with whom were Mr. Badcock and Mr. Waggett), for the plaintiffs, opposed the application. He urged that the defendants had, by means of their appeal, obtained the benefit of a suspension of six months, and yet they had done nothing to abate the nuisance. It was impossible to rely on the evidence that the proposed alterations would be effectual, for Mr. Bailey, in his affidavit, did not even now admit the existence of any vibration.

The Court granted an extension of time till August 5 next.

Lord Justice Lindley said that the duty of the Court was plain. On the one hand, they were bound to see that private rights were not infringed; on the other hand, they were bound to protect even wrongdoers against oppression by what was known as "blackmailing." In the present case, his Lordship thought that some extension of time would be reasonable. He was not much impressed with what had been said about the turbines. But he thought there was reason to believe that the removal of the four vertical engines would diminish the vibration; and the evidence satisfied him that the defendants *bonâ fide* desired to abate the nuisance. The time would be extended to August 5 next, but the defendants must give an undertaking to be answerable in damages to the plaintiffs; and the defendants must pay the costs of the present application.

Lord Justice Lopes and **Lord Justice Rigby** concurred.

The application for an extension of time was made in the first instance to Mr. Justice Kekewich, by whom the actions were originally tried. He thought that as he had refused to grant an injunction which was afterwards granted on appeal, the application ought to be made to the Court of Appeal.

Their **Lordships** said that, notwithstanding the fact that the injunction, refused by the judge of first instance had been granted by the Court of Appeal, the application for an extension of time was properly made to the judge of first instance.—*The Times.*

COMPANIES' MEETINGS.

CONSOLIDATED TELEPHONE CONSTRUCTION COMPANY.

The fourteenth annual ordinary general meeting of the Consolidated Telephone Construction and Maintenance Company, Limited, was held last week at Winchester House, E.C., Mr. C. L. W. Fitzgerald occupying the chair.

The **Chairman**, in moving the adoption of the report and accounts, said the manufacturing profit during the past year was £1,403. The amount available for disposal was £2,866 from which it was proposed to pay a dividend of £1. 10s. per cent., leaving £1,236 to be carried forward. Competition had been exceedingly severe, and while the wages and expenditure remained practically the same, somehow or other at the end of the year the profit was always less. For the past three years the amounts had been £17,000, £15,000, and £13,000, and his personal view was that the Company was the victim of free trade, foreign competition, and high wages. It was now in contemplation to remove the offices from London into the country, where both labour and raw material were cheaper. In order to enlarge the scope of the Company's business arrangements had been concluded with the patentees of the capsule battery, by which the Company obtained the sole right to manufacture all supplies during the term of the patent—viz., 14 years. The chairman having reviewed in detail the history of the lawsuit in Belgium, said that the Company had been successful on appeal, and he hoped that when they next met he would be able to place a satisfactory statement before the shareholders.

Sir Alexander Armstrong seconded the motion.

Mr. Buck was of opinion that it would be a very risky thing for the Company to undertake the capsule battery business, and with regard to the removal of the factory, suggested that it would be more advisable to ask the landlord to reduce the rent than to incur the expense of migrating to the country.

After some further discussion the report was adopted unanimously.

At an extraordinary general meeting afterwards held, resolutions were passed increasing the powers of the Company and altering the title to the Consolidated Telephone Construction and Manufacturing Company, Limited.

HOBART (TASMANIA) ELECTRIC TRAMS.

The second general meeting of the Hobart Electric Tramway Company was held at the offices, College-hill-chambers, Cannon-street, on Tuesday, Dr. Alfred Mattei occupying the chair.

The **Chairman** stated that during the year they had carried 2,478,938 passengers, and had run 584,117 car miles, and their latest advices reported that for the month of April they had reduced their working cost to 6½d. per car mile. The Board were doing all in their power to reduce expenditure. The standing item of interest upon the first and second mortgage debentures could not, of course, be reduced. The line was being worked more cheaply than formerly, for there they were now doing the work themselves, instead of putting it out to contract, which was necessary in the first instance. Their revenue, taking everything into consideration, was satisfactory. Tasmania, in common with the rest of Australia, had gone through a great crisis, and they had suffered with the rest. Not only had people travelled less for necessity, but the pleasure traffic had also fallen off. It would be seen that they had increased their second mortgage bonds by £5,000, and these bonds now stood at £20,000, making, with the £30,000 of first mortgage bonds, a total of £50,000. With this £5,000 they had settled the liability of Messrs. Siemens Bros. and Co. of £3,400, and the vendors £500, leaving a small balance in hand. He believed that their next balance-sheet would compare favourably with the present one. They had not lost sight of their project of lighting Hobart by electricity, but he could not say more upon the subject at the moment. Their outlook was encouraging.

The report was adopted.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL COMPANY, LIMITED.

The fourth annual meeting of the above Company was held on Wednesday at Winchester House, E.C., under the presidency of Mr. John MacFarlan, the chairman of the Company.

The **Chairman** said: Gentlemen, I do not think there is much in the balance-sheet that requires explanation; but if there should be anything not quite clear the auditors are here, and can reply to any question you may put with reference to the accounts. As we held the meeting last year in December, you are in possession of all information with regard to the position of the Company up to the end of the year, and I would only beg to draw your attention to the trading account in the metal balance-sheet, from which you will see that the loss on that account was practically nil. We think that, bearing in mind the difficult time we had during the year 1894, this result is satisfactory. As to the present position and progress of the Company, I am glad to inform you that from January 1 to June 8—that is, to Saturday last—the weight of goods sold amounts to 63½ tons, as against 22 tons for the same period last year, or, roughly, three times as much. This is a great advance, and one that should

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continue and even increase with greater rapidity. An important point to be observed is that, although the price of copper has been low—in fact, the lowest on record—our prices have remained high, averaging £98 to £100 per ton. It has been a source of pleasure to the directors to find how the products of the Company have won their way into the esteem of consumers. This is exemplified by the fact that during the 23 weeks ended Saturday last we received 397 orders, as against 579 orders during the whole of last year, and that our customers have increased from 243 on December 31 last to 309 on the 8th inst. As to repeat orders, I will only say that we have received a large number—in some instances as many as 71 from one customer—a fact which I think fairly permits us to hope for much in the future. The duplicate order book is on the table, and I have no doubt you would like to inspect it, and see for yourselves the number of repeat orders we have received. We have this year introduced a new article made by the Elmore process which is likely to monopolise the market. This is a copper condenser cover for torpedo boats, and we have already supplied several to the Government contractors in Germany. We also continue to supply air chambers, corrugated tubes, and other articles of an irregular shape. The new plant is giving great satisfaction, and upon it being found successful we at once spent a considerable sum of money in altering and improving the old plant, and we are pleased to state that this is now as complete as that erected last year. It has taken a certain amount of time to complete the alterations, but the increase of production and the saving in the cost thereof will repay both the time and the money expended upon it. Notwithstanding this, however, we anticipate before the end of the year that the capacity of the present plant will be taxed to the utmost, and therefore we have to bear in mind the question of increasing it. You will, perhaps, remember that we can add a large number of tanks without additional buildings. As a matter of fact, we can add no less than 61 large tanks in our present building, capable of producing a further 15 tons a week, and you will readily understand that while the capacity of the factory would be increased to this large extent, the cost of production would be considerably less in proportion, as the standing charges would be about the same. The amount of profit would, therefore, be greatly increased. It is not proposed to put down the whole of the new plant at once, but only as and when the amount of work in view justifies it. We hope to be able to put down a further 16 tanks—equalling four tons a week—before the end of the present year, and as we have found the great value of the draw bench, we are also desirous of further augmenting this department by putting down a drawbench very much larger than those we have at present, in order to enable us to draw much larger diameter tubes than is now in our power. In conclusion, I would only state that your directors are satisfied that the shareholders are the owners of a concern that is likely to prove a valuable property. Of course, we have had our troubles—indeed, I should like to know the concern that has not; but we have worked hard to overcome those troubles, and I can only say that we are now commencing to be repaid. I want you to remember that the accounts before you are for the year 1894, and although the issue of the preference shares was a success, that year was not so productive as it would otherwise have been, owing to the new plant not being finished, and therefore it is no criterion of what can be done this year. There is one point, perhaps, I should mention and that is that we have been approached in two or three different directions by capitalists offering to find large sums of money for filling the factory with plant, and for the purposes of the Company generally. Our reply has been that the shareholders have had to wait a long time for a return upon their capital, and the directors do not see their way to enter into any scheme whereby the shareholders would lose any portion of the profits which are likely to come to them. I now beg to move the adoption of the report and accounts.

Mr. John Heal seconded the motion, which was adopted after some discussion, complaints being made by **Mr. Peters** and **Mr. Gladstone.**

The retiring director (the chairman) was re elected, on the motion of **Mr. Heal**, seconded by **Mr. Peters**, and the auditors (Messrs. Cooper Bros. and Co.) were reappointed.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Clevedon (Somerset).—Tenders are invited for the public lighting of their district every night in the year from sunset till midnight, for the Urban District Council. Tenders to be for one, two, or three years, and to be sent to Mr. Hy. C. Fry, clerk, Clevedon, by July 1.

Braila.—Tenders are invited by the municipal authorities of Braila, Roumania, by June 17 (29), for lighting the town by gas and electricity. Security required, 25,000f.—Tenders are also invited by June 17 (29) for the construction and working of electric tramways in Braila. Provisional security, 10,000f.

Cardiff.—Tenders are wanted for the supply of steam coal for the electric lighting station for half-year ending December 31, for the Corporation. Specification may be seen, and forms of tender obtained, on application at the office of Mr. W. Harpur, M.I.C E., borough engineer. Sealed tenders, endorsed "Coal for Electric Lighting Station," to be delivered at the office of Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, by 17th inst.

London, E.C.—Tenders are invited by the G.P.O. for the purchase of about 35 tons of old copper (wire, plates, etc.), a large quantity of other metals (brass, zinc, iron, and steel), india-rubber-covered wire, mercury deposit, indiarubber, tinfoil, felt, rope, tar barrels, raw hide pieces, etc. A form of tender can be obtained from Mr. Charles E. Stuart, controller of stores, G.P.O., Telegraph-street, E C. Tenders will be received until Monday, June 17.

Preston — Tenders are invited for the wiring and fittings required for the lighting by electricity of the Town Hall and public hall buildings. Specifications and conditions at the borough engineer's office, Town Hall, Preston, on payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Separate sealed tenders for each of the buildings must be sent to Mr. Henry Hamer, town clerk, Town Hall, Preston, endorsed "Tenders for Electric Lighting," by 12 noon on July 1.

Bedford.—The Electric Light Committee are prepared to receive tenders for the supply and erection of the following plant: Section A—Two water tube boilers; Section B—two 140 b.h p. double-acting compound enclosed engines; Section C—two 90-unit alternators with stationary armature. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. T. G Porter, clerk to the Urban Sanitary Authority, on payment of a fee of 7s. 6d. for each section. Tenders, sealed, and marked "Electric Lighting, Section A, B, or C," are to be delivered by Tuesday, 25th inst.

Bradford.—Tenders are invited for the supply of best gas coal, cobbles, nuts, and cannel, all to be well screened, dressed, and free from shale and pyrites, to be delivered at the several works of the Corporation in the borough during one year or two years, commencing August 1, for the Gas and Electricity Supply Committee. Form of tender, with any further information required, may be had on application to Mr. Wood, gas engineer, Town Hall. Sealed tenders, endorsed "Tender for Coal," to be sent to Mr. W. T. McGowen, town clerk, Town Hall, Bradford, by July 3. An assurance must be given by each contractor that he pays to the workmen employed by him not less than the minimum standard rate of wages.

London.—The Secretary of State for War gives notice that purchases for specific quantities of various articles will be made from time to time during the current year. Among them are electrical instruments for submarine mining and telegraph cable and wire. Manufacturers who may be desirous of tendering should apply to Mr. G. Lawson, director of army contracts, War Office, Pall-mall, S.W., by letter, giving at least names of two well-known firms or public bodies who have purchased from them and are in a position to certify as to the quality of their productions. Applications unaccompanied by references will not be noticed. Firms whose names are already on the War Office list need not apply, as forms for tendering will be sent to them in due course.

Inverness —Tenders are invited for the following articles, among others, from July 1, 1895, to June 30, 1896, delivered free of all charges, viâ Dunkeld, at the company's storehouses, Inverness, for the Highland Railway Company: telegraph instruments and fittings and telegraph construction material. Forms of tender may be had on application to Mr. J. G. Bulmer, storekeeper, Inverness. Tenders, properly endorsed, sealed, and addressed to the directors, must be lodged with Mr. And Dougall, secretary, Inverness, by 22nd inst. Separate forms of tender will be provided for each contract; parties are therefore requested to specify the particular contract or contracts in respect of which they propose to submit tenders. Those we have noted are respectively numbered 17 and 17A.

Madrid.—The Spanish Postal and Telegraphic Administration invites tenders by June 28 for the supply of 20 tons of copper. Preliminary security 5 per cent., definitive security 10 per cent., maximum price 520 pesetas per ton. Conditions, etc., and forms of tender from La Direccion General de Correos y Telégrafos, Madrid.—The Spanish Postal and Telegraphic Administration invites tenders by June 29 for the supply of 40,000 white and 10,000 grey porcelain insulators. Maximum price, 1 peseta 5 centesimos for the white and 1 peseta 10 centesimos for the grey. Provisional security, 2,650 pesetas; definitive, 10 per cent. of the estimate. Tenders are also invited by June 30 for the supply of 25,000 zinc cylinders for Calland elements. Maximum price, 980 pesetas per 1,000; provisional security, 1,225 pesetas; definitive, 10 per cent. of the estimate. Conditions and forms of tender from La Direccion General de Correos y Telégrafos, Madrid.

St. Helens.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of the following plant: Section A—boiler-house plant, including boilers and fittings, forced-draught apparatus, feed pumps, etc.; Section B—engine-house plant, including steam alternators, oil-filter, fittings, etc., steam, exhaust, feed, blow-off, and sundry pipes, valves, and water-tanks, etc.; Section C—main switch-board and instruments; Section D—underground work, including cables, junction-boxes, culverts, and trenching; Section E—transformers and fittings; Section F—meters; Section G—overhead crane. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. The ground plan of plant, plan of streets, etc., and specification, with terms and conditions of tender and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on and after June 11, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed, and marked "Tender for Electric Lighting,"

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must be addressed to the town clerk at the Town Hall, St. Helens, and be delivered on or before Tuesday, July 2.

RESULTS OF TENDERS.

Exeter.—For carrying out an installation of the electric light at the Museum: Electrical and General Engineering Company, £299. 10s. (accepted).

Halifax.—The tender of the Electric Construction Corporation, Limited, for the supply and fixing of a combined alternator and a Pollit and Wigzell engine has been accepted by the Town Council, the cost being £3,050.

Shoreditch.—Twenty-seven tenders were opened by the Shoreditch Vestry for the electric wiring of the Town Hall upon the specification provided by the Town Hall Committee. There was considerable divergence in the prices, the highest tender amounting to £848, while the lowest, sent in by the Electrical and General Engineering Company, and accepted by the Vestry, amounted to £178.

Brighton.—For the supply and erection of arc lamps, switches, etc., for the Town Council:

Sharp and Kent, Victoria-street, Westminster (accepted)	£2,167
Crompton and Co., Limited, Mansion House-buildings, E.C.	2,838
J. A. Edmundson, Grove Electrical Works, Leeds	2,757
Siemens Bros. and Co., Limited, Queen Anne's-gate, Westminster	2,988

Tenders were also received from Johnson and Phillips and the Electrical Engineering Company, but being informal were not entertained.

Hanley.—Tenders for various contracts in connection with the electric lighting extensions have been accepted by the Town Council of this borough, as shown in the following list:

Contract No. 11.—Surface Condensing Apparatus.

C. A. Parsons and Co., Newcastle-on Tyne	£1,390	0	0
J. Fowler and Co., Leeds	1,009	0	0
Crompton and Co., Chelmsford	895	0	0
J. Watt and Co., Birmingham	885	0	0
S. Z. de Ferranti, London	845	0	0
Electric Construction Company, Wolverhampton	842	0	0
Johnson and Phillips, Old Charlton	806	0	0
Siemens Bros. and Co., London	802	0	0
Brush Electrical Engineering Company, London	786	0	0
W. H. Allen and Co., Bedford (accepted conditionally)	755	0	0
British Thomson-Houston Company, London	740	0	0
T. Shore and Sons, Hanley	618	0	0

Contract No. 12.—Two Lancashire Boilers, etc.

Davy Bros., Limited, Sheffield	1,718	0	0
D. Adamson and Co., Dukinfield	1,645	0	0
Hawksley, Wild, and Co., Sheffield	1,450	0	0
Tinkers, Limited, Hyde	1,400	0	0
J. Adamson and Co., Hyde	1 390	0	0
J. Thompson, Wolverhampton	1,250	0	0
Brush Electrical Engineering Company, London	1,228	0	0
W. R. Renshaw and Co., Stoke-on-Trent	1,180	0	0
E. Danks, Oldbury (accepted conditionally)	1,178	0	0
H. and T. Danks, Limited, Dudley	1,060	0	0

Contract No. 13.—Water-tank, etc.

Peirson and Co.	423	0	0
Brush Electrical Engineering Company	243	0	0
Cowlishaw, Walker, and Co.	225	0	0
E. Danks	205	0	0
Cochrane and Co.	185	0	0
J. Warner and Sons	180	0	0
T. Shore and Sons	170	0	0
J. Thompson	167	10	0
W. R. Renshaw and Co. (accepted)	164	18	0

Contract No. 14.—Arc Lamps and Posts.

The tenders and designs received demand more time for consideration, and are consequently deferred to the next meeting of the Council.

Contract No. 15.—Electric Light Mains—High and Low Tension Cables.

Laing, Wharton, and Down	2 084	10	0
Brush Electrical Engineering Company	1.757	10	10
W. T. Glover and Co.	1,666	10	4
W. T. Henley's Company	1,665	3	6
India Rubber and Gutta Percha Company	1,657	17	0
Siemens Bros. and Co.	1,609	5	10
Fowler-Waring Cables Company	1,525	19	0
Telegraph Manufacturing Company	1,521	12	0
Johnson and Phillips	1,509	18	4
British Insulated Wire Company (accepted)	1,393	8	4
W. R. Renshaw and Co. (the same, but including Kingdon's patent wrought-iron cover)	2,290	6	8
Callender's Bitumen, etc., Company (low-tension mains only, including laying)	1,730	13	4
Stanton Iron Company (for 2in. cast-iron pipes, at per ton, accepted)	4	12	6

Contract No. 16.—Transformers, with High and Low Tension Switches.

C. A. Parsons and Co.	888	0	0
Siemens Bros. and Co.	822	0	0
Johnson and Phillips	738	0	0
Electric Construction Company	694	10	0
Crompton and Co.	675	0	0
Brush Electrical Engineering Company (accepted)	632	2	0
J. Fowler and Co.	623	8	0

BUSINESS NOTES.

Great Northern Telegraph Company.—For the month of May the receipts were £28 400.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,650.

Phonopore Company, Limited.—The transfer books of this Company will be closed until the 27th inst.

Commercial Cable Company.—The Commercial Cable Company have declared a quarterly dividend of 1¾ per cent.

Folkestone.—At the last meeting of the Town Council the consideration of the electric light question was adjourned.

Belfast.—Mr. Stelfox, the gas engineer to the Belfast Corporation, has applied for current for electric lamps at the gasworks for use where open gas jets would be dangerous.

Wallasey.—At a meeting of the District Council, Captain Herron stated the introduction of the electric light at Seacombe was being arranged for if it could be procured as cheap as gas.

Harrogate.—The Town Council have resolved that the electric lighting scheme should be entirely reconsidered, and that the question of utilising town's refuse in the boilers should be omitted from the plans.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 2nd inst. amounted to £1,671, as compared with £843 in the corresponding week of last year, being an increase of £828.

Theatre-Lighting.—Messrs. Roger Dawson, Limited, inform us that they have received the order for supplying the complete electric light fittings for the Empire Palace of Varieties now being built at Blackpool.

Oswestry.—The Town Council have held a meeting at which it was stated that the Board of Trade recommended that earthenware instead of iron pipes should be used in laying down the proposed electric light.

Aberystwith.—At the last meeting of the Town Council it was stated that Mr. W. H. Preece, owing to great pressure of business, had been unable to send his promised report on the electric light, but would do so shortly.

Reflector Syndicate, Limited.—This Company has been registered, with a capital of £2,000, to carry into effect a certain agreement, and to carry on business as manufacturers of and dealers in reflectors and projectors.

National Telephone Company, Limited.—The transfer books of the 3½ per cent. debenture stock will be closed from 17th to 29th inst., inclusive, for the preparation of warrants for the half-year's interest, due July 1.

Chiswick.—A meeting of the Urban District Council has been held at which the surveyor reported that the electric lighting works had been stopped pending the decision of the Council relative to the height of the shaft.

Metropolitan Electric Supply Company, Limited.—The transfer books of the 4½ per cent. first mortgage debenture stock will be closed from 17th to 30th inst., both days inclusive, for the purpose of preparing interest warrants.

Private Bills in Parliament.—The Great Northern and City Railway (Extension of Time) Bill and the London County Council (Money) Bill, have been considered by the House of Commons Committee and ordered for a third reading.

Fire Prevention.—The Hampstead Vestry's electric lighting station has been fitted up with Heathman's improved fire-hydrants, with hose and fittings so positioned as to be available for prompt service in the event of an outbreak of fire taking place.

Telegraph Manufacturing Company, Limited.—The ninth ordinary general meeting of this Company was held on Friday last, and the usual distribution of profits was declared—viz., a dividend of 5 per cent., and in addition a bonus of 2½ per cent., both free of income tax.

Telescopic Ladders.—The British Thomson-Houston Company have ordered from the Heathman Patent Ladder Company, of Endell-street, W.C., two telescopic ladder tower wagons for the erection and repairs of trolley wires on the Dublin electric tramway system now being constructed.

Connolly Bros., Limited.—This Company has been registered, with a capital of £20,000, to adopt a certain agreement for the acquisition of the business of Connolly Bros., of Blackley Vale Mills, Blackley, Lancashire, insulated cable manufacturers and electricians, and to develop and extend the same.

Oxford.—The New Municipal Buildings Committee of the Town Council have reported that in the estimates a sum of £1,000 had been set aside for electric wiring, and £600 for electric fittings. The committee have obtained contracts for or definitely appropriated sums for various contracts, including £740 for the wiring.

City and South London Railway.—The returns for the week ended June 9 were £904, compared with £911 for the corresponding period of 1894, being a decrease of £7. The total receipts for the current period of the present half-year are £21,437 against £20,924 in the corresponding period of 1894, an increase of £513.

Southport.—A meeting of the Town Council has been held, at which a long discussion took place on a motion moved by the chairman of the Electricity Committee, Councillor Hesford, that a

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scheme be adopted of differential charges for electricity so as to encourage consumption. After a long discussion the minutes were passed.

Paddington.—The Electric Lighting Committee of the Vestry have reported that the clerk had been instructed to write to the Metropolitan Electric Supply Company, enquiring whether it was their intention to construct transformers in the main thoroughfares, and if so, whether they possessed the necessary parliamentary powers.

Dispute at the Edison and Swan Electric Light Company's Works.—The Electrical Trades Union on Tuesday issued a manifesto to the organised workers of London, in which it is stated that in the negotiation for a settlement of the dispute at the Ponder's End works of the company it has become necessary to prepare for a long struggle, and an appeal is made for moral and financial aid to assist the 400 men, women, and boys affected.

The Military Tournament.—A novelty of electrical interest introduced during the last week of this show consisted of a search-light, with oil-engine and dynamo combined, on a light three-wheel trolley, intended for field service and for flashing signals. The plant was designed and manufactured by the Dawson Gas-Engines Syndicate, Limited, of 76, Queen Victoria-street, E.C. The engine was one of their special high-speed type, running at 800 revolutions per minute, and coupled direct to the dynamo shaft.

Blackburn.—The electric light is finding much favour in Blackburn, and seems likely to be pretty extensively used, not only publicly, but by private consumers. The Town Council, it is worthy of note, have just decided upon an extension of the light, it having been resolved to adopt the scheme of lighting Railway-road and Salford Bridge with this illuminant. It has been decided by the Gas Committee that the price of current shall be reduced to 6d. per unit for illuminating purposes from the end of the quarter.

Electric and General Investment Company.—The directors have decided to recommend the payment of a further dividend on the capital paid up on the ordinary shares at the rate of 30 per cent. per annum for the six months ended May 31 last, making, with the interim dividend already paid, a total dividend of 20 per cent. for the year, and also to make a distribution of £35. 16s. on each founder's share for the year. The transfer books will be closed from 19th inst. to July 2, both days inclusive, for the purpose of preparing the dividend warrants.

West Bromwich.—The Board of Trade have again renewed the license for the use of steam on the South Staffordshire tramways for one month from May 15. At a meeting of the Town Council, Alderman Heelis, as chairman of the Highways Committee, said there appeared to be an impression among the public that the committee were hampering the tramway company. The committee had no wish to hamper the company, but more to assist them. They had the public convenience to watch, and what they wanted was a proper means of locomotion.

Appointment.—The Shoreditch Vestry invite applications for the appointment of clerk of works, with practical building experience, to supervise the erection of a dust destructor and electric lighting station, buildings, and connected works on behalf of the Vestry, and under the direction of the consulting engineers. The salary will be £3. 3s. per week. Applications, on forms to be provided, with copies of not more than two recent testimonials, must be sent to Mr. H. Mansfield Robinson, vestry clerk, Town Hall, Old-street, E.C., by noon on 24th inst., endorsed "Clerk of Works."

Tumbler Switch.—We are informed that the action for infringements of the link switch patent brought by the General Electric Company against Messrs. W. McGeoch and Co, and others, has been settled on terms satisfactory to all parties in preference to taking the matter into court. Messrs. W. McGeoch and Co., Verity and Sons, and Evered and Co. have taken licenses from the General Electric Company, under which they will continue to manufacture and sell tumbler switches with the heel-piece as before. The Edison and Swan Company have also for some time been licensees for this patent.

Burton-on-Trent.—The Gas and Electric Light Committee have, as we have previously announced, recommended that the tenders of the Sheffield Coal Company, the Staveley Coal and Iron Company, and J. and G. Wells be accepted. The committee also recommended that the tender of the Telegraph Manufacturing Company, of Helsby, near Warrington, be accepted for the high and low pressure cables for the extension of the electric light system across the Burton Bridge and along Ashby and Alexandra roads. The tender of the Stanton Ironworks Company for cast-iron pipes for the same works was also recommended for acceptance.

Holbeach.—The Urban District Council have held a meeting at which tenders for street-lighting by oil, gas, and electricity were received. The gas company tendered for gas lighting at £2. 3s. 4d. per lamp for the season, or 4s. 2d. per thousand feet, two special lamps to be supplied by meter. Mr. Bean tendered for oil at £140 for the season, and Mr. T. Barton, of Blackburn, through Mr. Bean, tendered for electric lighting at £210 for the season, for a term of seven years. The total cost of the gas for the season was estimated to be about £165, and the company's tender was accepted. This is the same rate per lamp as last year, but the time of lighting has been extended.

Fulham.—The Electric Lighting Committee recommended the Vestry at its last meeting to invite an engineer to furnish a report on the introduction of the electric light with a dust destructor into the parish for a fee of 50 guineas. Mr. Drew thought there was not the slightest likelihood of having the electric light introduced into the parish, and any money spent upon it would be entirely thrown away. The class of house in the parish did not call for the light. At the suggestion of the Chairman the matter was adjourned until the next meeting. Messrs. Kincaid, Waller, and Manville have been recommended to advise the Vestry in the matter of electric lighting at a fee of 50 guineas.

Wigan.—A meeting of the County Borough Council has been held, at which Mr. Holmes moved the confirmation of the Gas and Electric Lighting Committee's minute. Alderman Phillips said he was being continually twitted and asked when they were going to have the electric light in the town, and also if it was a fact that members of the committee were controlled by certain gentlemen outside the Council. Mr. Holmes said he was not aware of any outside influence being brought to bear on the committee. It was true the sub committee had had several meetings, but up to the present time did not see eye to eye as to carrying out the electric light. It might be that within a short time the thing would be carried forward. Speaking individually, if they were to have the electric light they ought to be moving. It was time it was put into active operation, or placed on the shelf altogether. The minutes were confirmed.

Aberdeen.—At a meeting of the Gas and Electric Lighting Committee of Aberdeen Town Council, it was agreed to recommend that the electric mains should be extended along Bridge-street, a number of applications for supplies of current having been received from occupiers of premises in that thoroughfare. The cost of extension is estimated at £310. A copy of regulations forwarded by the Board of Trade with reference to the mains and culverts in connection with electric lighting systems was submitted to the meeting, as also was a report by Mr. Blackman, electrical engineer, and Mr. Smith, gas manager, stating objections to certain of the regulations. It was further reported that the Corporations of Glasgow and Hull intended to lodge objections. The committee resolved to consult Prof. Kennedy, London, on the points raised, and Mr. Blackman, who is to be in London soon on Corporation business, will submit the objections to the professor.

Dundee.—Mr. W. E. L. Gaine, general manager of the National Telephone Company, Limited, has issued the following notice: "Arrangements have been made with the Post Office authorities by which the subscribers to the company's local exchange system at Dundee may telephone their telegrams direct to the post office in that town by means of the exchange instruments fixed upon their premises. Telegrams may also, where the Post Office regulations permit, be transmitted from the post office to subscribers in a similar manner in lieu of delivery by messenger, on the subscriber signifying in writing to the company his wish to that effect. The company do not propose to make any charge for these additional and valuable facilities, but subscribers wishing to take advantage of these services must sign the usual agreement form, and deposit with the company an amount sufficient to cover the cost of any telegrams they are likely to transmit during the period of one month from the date of such deposit, the amount of which deposit must not be less than £1."

Kensington.—A meeting of the Vestry has been held, at which the Works Committee reported that notices and plans had been received from the Notting Hill Electric Lighting Company, relative to extensions of their mains in Addison-road and Addison-crescent, alternative proposals being submitted for laying armoured cables or the ordinary cables in three 1¼in. pipes. The committee recommended that the company should be informed that the Vestry were unable to sanction the use of armoured eable in their district, and that permission should be given for the laying of cables in iron pipes, subject to the following conditions—namely, "That the size of the pipes be approved by the Vestry's surveyor and the lighting engineer. That the plans be approved by those officers, and that the works be carried out under their supervision and to their satisfaction. That the works be completed within three months of the date of sanction. That the boxes be efficiently protected against accumulations of gas and water." The report was agreed to without discussion.

Middlesbrough.—A meeting of the Electric Lighting Committee of the Middlesbrough Corporation has been held for the purpose of considering the advisability of recommending the Town Council to adopt electric lighting for the town. A special committee visited several towns last year and inspected the various systems in operation. In all cases they were found to act well, and consumers testified to the light being superior to gas The cost of an installation would be 50 per cent. more at Middlesbrough than gas, but this was counterbalanced by the greater illuminating power. It was agreed to recommend the Council to lay down an electric installation at a cost not exceeding £25,000, this being sufficient to meet the present requirements of the town. The Electric Lighting Committee's report came before the Town Council on Tuesday. After some discussion, Alderman Hugh Bell moved, as an admendment, that the matter be referred back and that the committee be requested to report the smallest amount for which electric plant could be obtained. Alderman Hinton seconded the amendment, which was agreed to.

Manchester.—A novel application of electricity which is certain to attract much attention on the part of railway travellers who use Victoria Station, Manchester, is now to be seen at work at that centre of traffic. For some time the necessity has been felt of increasing the facilities for dealing with the parcels business at the station, and the apparatus now in use has been designed with

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that object. Hitherto the subways have been employed, but an alternative method has been supplied by the construction of an overhead tramway, extending from the old parcels office on No. 3 platform to No. 8 platform, where the new parcels department is now situated. This miniature tramway is suspended from the girders of the roof Along the rails run an electric motor capable of lifting and conveying a ton, but not used for more than half that weight When parcels have to be transferred to or from the office they are placed in the hamper, and it is then wound up to its place under the motor, which at once runs off under the control of a workman, who is able to stop it and let down or pick up his hamper at any point he pleases. At present only one set of rails is in use, but the company are fixing a second pair to run alongside the first.

Chester.—A meeting of the Town Council was held on Wednesday, when the report of the Electric Lighting Committee showed that the committee recommended the Council that they be authorised to accept the offer of Thos. Parker, Limited, Wolverhampton, to supply an electric light installation for the city for £14,200, exclusive of buildings, etc., estimated at £3,000 (total £17,200), and to run it for a period of one, two, or three years, to supply public and private lighting at the prices named, and to arrange the terms of the necessary contract and do what might be necessary to get the installation established. It appeared from the minutes that the committee made the recommendation on the advice of Lord Kelvin. Mr. B. C. Roberts, in moving the adoption of the recommendation, said that in delaying so long in carrying out the electric lighting of the city they had lost nothing, but gained a great deal. They had got all the newest improvements and had also gained other advantages, one of which was that they were to obtain the energy at so low a price that he hoped they should be able to supply the electric light to the city and the citizens at a comparatively lower price than gas. The motion was adopted.

The Foyers Aluminium Works.—A beginning has been made with the works for the abstraction of part of the water from the River Foyers for the purpose of generating power to produce aluminium from alumina, which is to be brought to Loch Ness from Ireland. Mr. Peregrine Birch, M.I C.E., has designed the works, and has the superintendence of them, and Mr. Andrew Ainslie Common, one of the directors of the British Aluminium Company, Limited, for whom the works are being constructed, was also at Foyers last week to see the start made. Foyers House, which was formerly a shooting-box, but which has been in a ruinous condition for about a score of years, has been secured by the company for the use of workmen, and is now fitted up as a commodious lodging-house with some 50 beds. It is expected that about 130 to 150 men will soon be engaged. The works now begun include the extension of the pier at Foyers in Loch Ness by 200ft., the construction of a tunnel (half-a-mile in length) through rock for the conveyance of the water to a point where the fall will be made through pipes, the power thus obtained being expected to reach between 2,000 h.p. and 3,000 h.p. There will be other work to do before the production of the metal can be in progress.

Birkenhead.—The Council have had a meeting, at which Mr. Snape, referring to the acceptance of various tenders for the erection of the electric lighting station, asked if the chairman had any great hopes of the electric light being started by the autumn, and whether the £20,000 originally stated as the first cost of the undertaking was likely to be exceeded. Alderman Deakin said Mr. Shoolbred advised them it was likely—in fact, certain from his point of view—that the electric light would be ready for the winter months, provided these tenders were now accepted. The various tenders up to this point amounted to about £13,000, and they were advised by Mr. Shoolbred that the remainder of the work could be done for less than the difference between the amount and the £20 000 referred to. Mr. Snape: Is the amount of the purchase of the land included in that £20,000? Alderman Deakin: Yes. Mr. Snape: How much was that? Alderman Deakin: £1,500. Mr. Snape maintained it would be nearer the mark to say the autumn of 1896 than that of 1895, and in view of the fact that the whole of the estimates of the proposed expenditure were not complete, he moved that the acceptance of the various tenders named be not confirmed There was no seconder, and the minutes of the Finance Committee were then confirmed.

Bangor (Wales)—According to the reports of the Electric Lighting Committee presented at the last meeting of the Council, it appeared that Mr. Thomas Lewis was elected chairman, and Mr. J. Gill clerk. On the motion of Mr. Henry Lewis, seconded by the Mayor, Mr. T. H. Medhurst was appointed consulting engineer at a fee not exceeding 25 guineas, including expenses for preliminary report and advising the committee generally; and should the committee proceed with this matter, that Mr. Medhurst be engaged as engineer, the present fee to merge into his commission. On the motion of Dr. Grey Edwards, seconded by Mr. Robert Hughes, the engineer was asked to report on the feasibility and cost of lighting the city with electricity, and advising generally as to the adoption of the Electric Lighting Acts. On the motion of Mr. J. E. Roberts, seconded by Mr. Richard Davies, Dr. Grey Edwards and the borough surveyor (Mr. J. Gill) were asked to prepare a list of questions to be submitted to towns of similar size to Bangor as to the working of the electric light in their districts. Mr. Thomas Lewis and Dr. Grey Edwards were also appointed to accompany the electrical engineer on his visiting Bangor. The committee had under their consideration a report sent in by Mr. Druce (representing the Edison-Swan Company), for which the committee thanked the latter. On the motion of Mr. Thomas Lewis, seconded by Mr. T. G. Williams, the committee's reports were adopted by the Council.

Rangoon.—Besides advertising, the Rangoon Municipality are making enquiries through their agents to acertain the terms upon which electric lighting plant can be erected for lighting the streets of Rangoon, and the cost of working and maintaining it; what the streets could be lighted for if the plant were erected and worked by the tenderer, the plant remaining his property, and what terms of concession would be required for the sole right of supplying electricity to the Municipality. Underground cables must be laid within the town proper and overhead wires in the suburban and isolated areas. At the present the total cost of lighting the streets of Rangoon with kerosene lamps is Rs. 40,000 per annum, and the system is far from satisfactory. The suburbs are entirely neglected. The electric installation erected by the Irrawaddy Flotilla Company at the new Government House is, judging from the results of recent trials, quite a success. Besides being a very great improvement on kerosene lights, it adds immensely to the splendour of the interior of the building and shows to advantage the artistic ceiling. The engine and dynamo are so placed that the inmates of the building will not be disturbed by the noise attendant on the working of the machinery. This success has led to the company being recommended to carry out the electric lighting of the new public offices.

Halifax.—At a recent meeting of the Town Council, Alderman Brook proposed, and Alderman Enoch Robinson seconded, the acceptance of the tender of the Electric Construction Company, Limited, for the supply and fixing of a combined alternator and a Pollitt and Wigzell engine at the electric light station, for the sum of £3,050. Councillor Woodhead, replying to an observation by Councillor J. T. Spencer, remarked that this was a matter which could not wait. The committee had thought that, for the first winter, they would do well if they secured customers for 2,000 lights, and they prepared for that. Already, however, they had applications for over 3,000. They were bound to have a certain amount of reserve power, and, should one of their present engines fail, they would be unable to supply sufficient power. The number of applications for next winter, he believed would not be far short of 6,000 lights. The town clerk added that, under their Act, they were bound to meet the demands for lights, and unless they carried out the proposed extension it was possible that they would render themselves liable to £6,000 in penalties. The resolution moved by Alderman Brook was then agreed to. The authorities of the Halifax New Infirmary have decided to lay down a plant of their own to supply the institution with the electric light. They recently applied to the Electric Lighting Committee of the Corporation to grant them a supplementary service, so as to be prepared for contingencies. The committee have come to the conclusion that they would not be warranted in incurring the expense that would be involved. They would have been glad, however, to add the infirmary to their list of customers.

Weybridge.—The Urban District Council have held a meeting, at which the Highways and Lighting Committee recommended that a contract for the lighting of the district for a period of seven years should be entered into with the Weybridge Electric Supply Company. Mr. Ward opposed the adoption of the report, pointing out that it was not merely entering into a contract for seven years, but the Council would not be able to purchase the works for 40 years, and he asked them not to run their heads into a noose. He went into figures to show that the probable cost of the undertaking to them would be about £10,000, which at 3 per cent. interest meant an outlay of £300 per annum. On the other hand, they had to pay £3. 7s. 6d. per annum for each lamp, and as they would require £250 lamps at least, that would mean an outlay of £743, and he contended that it would pay them a great deal better to purchase the undertaking. He moved that the question be referred back to the committee for their further consideration. Mr. Bilney seconded the proposition, and severely criticised the manner in which the negotiations had been conducted on the part of the Weybridge Electric Supply Company. He doubted whether the security they offered for the carrying out of the contract, if entered into, was substantial enough. Dr. Powell opposed Mr. Ward's motion, and stated that they had taken the opinion of Captain Bax, who informed them that the district could not be lighted at a cheaper rate than £3. 7s. 6d., and that work of that description was always carried out more satisfactorily by a private firm than by a public body. He moved that the recommendation of the committee be adopted, but this finding no seconder, Mr. Ward's resolution was put and carried *nem. con.*

Hastings.—The Roads Committee of the Town Council have received from the secretary of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, notice of the intention of the company to extend their service mains (*a*) from the transformer-chamber opposite Old Christ Church, London-road, across London and King's roads to inspection boxes placed opposite to 28, King's-road, thence to 30, King's-road, and in the opposite direction to 24, King's-road, and (*b*) from a point opposite 3, Bank-buildings, to the Volunteer Drill Hall, Middle-street, in accordance with the plans forwarded with the notice, which notice fully specified the mode in which the works were intended to be executed. The committee had duly considered the notice and plans, and at the last meeting of the Town Council recommended that such plans be approved, subject to the works being carried out to the satisfaction of the borough engineer, and to the company giving the usual undertaking not to remove the covers of the boxes except between the hours of 10 p.m. and 9 a.m., unless in case of actual emergency. The Roads Committee also received from the company notice of the intention of the latter to extend their service main from their works, across the railway bridge, to an

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inspection box proposed to be constructed on the upper side of the junction of Braybrooke-road with Priory-avenue, in accordance with a plan submitted, and they recommended that the plan be formally disapproved, the arrangement of the carrying of the main over the bridge not being, in the committee's opinion, altogether satisfactory. The borough surveyor had received instructions to confer with the company's manager on the subject. The recommendations were carried by the Council.

Douglas (Isle of Man).—A meeting of the ratepayers of Douglas was held on the 6th inst. in the gymnasium for the purpose of considering an offer made by the Isle of Man Tramways and Electric Power Company, Limited, with regard to the leasing of the shore section of the tramway and the construction of a cable tramway to Upper Douglas. The electric tramway company proposed in return for a double line throughout the Douglas Bay line, and an extension of lease for 21 years in addition to three years unexpired, to grant the Town Commisioners an annual payment of 15 per cent. upon the gross traffic receipts of such line, the minimum payments to be £1,500 per annum. The company also undertook to construct and work a tramway to the upper part of Douglas. It was urged that by adopting the company's proposal there would be a saving by the Commissioners of 4d. in the pound in the rates. A resolution was proposed to the effect that in the general interests of the town it was important that the proposal, with such modifications as might be desirable, should be adopted by the Town Board. It was strongly urged that the company's offer should be accepted, and ultimately the resolution was carried by a large majority. At an adjourned meeting of the Douglas Town Commissioners on Monday evening, the draft agreement entered into between the electric tramway company and the Commissioners for the lease of Douglas Bay tramway for a further term of 21 years was considered. Several members contended that the offer of the company to pay 15 per cent. upon the gross earnings and to construct and work a tramway to Upper Douglas was insufficient consideration for the extension of the lease. An offer of Mr. H. Creppin (Manchester) to give 1 per cent. more than the tramway company was laid before the Board. After an exciting debate the draft agreement with the tramway company was confirmed by 10 votes to 8.

Rathmines.—The Rathmines and Rathgar Commissioners have held their monthly meeting, at which Mr. Hewson said he understood there had been some recommendations by the Parliamentary Committee with reference to the electric tram system, and with the view to opposing that system. He saw on the table a photograph representing portion of an electric tram line at present working, and he wished to point out that it gave a most unfair picture of the ordinary appearance of the overhead wire system. The photograph was taken at a point where there was a curve, and afforded quite an exaggerated idea of what was regarded by some people as the objectionable appearance of those wires. There was nothing in the system more objectionable than the ordinary tram system, and the wires were no more unpleasant to look at than the telephone wires. The action of the Board was simply in the direction of opposing the advance of science. Mr. Carey: I can only say that that picture is by no means exaggerated. These overhead lines are exceedingly unsightly. The Chairman: I may say that the question has been dealt with by the committee and a resolution come to to oppose the Bill for the introduction of the system. There was no intention whatever to oppose the advance of science. Mr. Carey said the overhead wires already erected in Leeds were most unsightly, and the authorities there refused to allow the erection of any more. Birmingham would not allow any more such wires to be erected, Blackpool would not allow overhead wires, and it was perfectly obvious that the general feeling was opposed to the system and in favour of underground wires as an alternative. They did not want to prevent the advance of science, but they were anxious and determined to prevent an unsightly and a dangerous system. The chairman again reminded the Board that the committee had unanimously determined to oppose the Bill. There was no doubt that the underground system could be adopted if the tram company chose to do so. The matter then dropped.

Wimbledon.—At a meeting of the District Council, Mr. Crimp stated that at a meeting of the Road and Drainage Committee Mr. W. H. Preece read his report on the proposed electric lighting. The matter was a very large and a very important one—probably the most important that had come before the Council for many years past. The committee, of course, could do nothing more than receive the report and ask questions upon it. The report contained a mass of details which could only be appreciated when the report was before the members and carefully studied. The committee, therefore, thought that the report should be printed and a copy sent to each member. There were two schemes. One scheme contemplated the lighting of the whole of the public lamps by electricity, and also a large number of private houses, at a cost for installation of something like £30,000, besides a very large expenditure for working expenses. The other scheme contemplated the lighting by electricity of only the main roads and the principal streets. Mr. Donaldson: I think it should be stated that Mr. Preece suggested that, after making allowance for the present cost of lighting by oil, the actual cost, at the worst, of the electric light would only be a few hundreds a year at first. Mr. Crimp: That is quite correct. I did not mention the matter because I thought this was not the proper time for details. But it is a most important fact, of course. I may add that Mr. Preece has an electric installation at his own house, and has kindly consented to put an electric light outside his house, and to change the candle-power at intervals, so that members of the Council may see what candle-power would be necessary. Mr. Crickmay thought the common was a very indifferent spot for an experiment of that kind. The Chairman pointed out that to have made the experiments in the Broadway would have involved a much greater cost. The spot was not an unsuitable one; it was a public thoroughfare, and very dark. Mr. Crickmay: If we are going to have an expenditure of £30,000, we ought to have the fullest possible experiments even if it costs us another £50. The matter was not further discussed.

Longton.—At a meeting of the General Purposes Committee, the town clerk reported that he had received from the Board of Trade a communication with reference to the application of the Corporation for sanction to use mechanical power (which has hitherto been refused) on portions of the tramway constructed in the borough in 1881. The Board of Trade now stated that, having regard to the street improvements which had been made and were in contemplation, and to the desirability, in the opinion of the Corporation, of extending the tramway system beyond the disused lines, the Board would be disposed to give a favourable consideration to an application for a provisional order authorising such lines afresh, and sanctioning the use of steam or other mechanical power thereon. It must, however, be borne in mind that at certain points a space of less than 9ft. 6in. would intervene between the rail and the nearest kerb for distances over 30ft., and that Section 9 of the Tramways Act, 1870, conferred upon the frontagers at such narrow places a certain right of veto. It would be the duty of the Board to give effect to this section in the event of an application being made to them, and also to give due consideration to any other objections that might be brought before them. It was resolved, "That application be made to the Board of Trade for a provisional order authorising the extension of the tramways in the borough to such points as may hereafter be decided upon, and sanctioning the use of steam or other mechanical power on the existing tramways and proposed extensions, and that the town clerk be instructed to take the necessary proceedings accordingly." At the same meeting a letter was read from the secretary to the North Staffordshire Tramway Company, Limited, stating that the company had had under consideration the subject of adopting some improved form of traction, and had come to the conclusion that the only method suitable for the district in which the tram lines were laid was that of electric traction by means of overhead wires, and asking for the consent of the Council to the general principle. A deputation was appointed to meet the directors of the company and discuss the matter and report to the committee.

A Visit of Enquiry.—The town clerk of Eccles has prepared a report of the visit paid recently by the Mayor and himself to the electric light works at Kingston-upon-Thames. Kingston is about the size of Eccles. He states that the electricity station is a model place. The buildings have been put up with a view to convenient extension, and one end thereof is covered by a simple corrugated iron framework, so that the new length could be put up without disturbing the walls. The Council has spent £18,000 in establishing electric light, including the cost of the buildings. The price charged is 6d. per unit for private consumers, which is reckoned to be equal to gas at 3s per 1,000 cubic feet, light for light, but with more light for the money than with gas. The works have been going about 18 months, and the results have been satisfactory. The light was taken up readily by the shopkeepers and by private residents, and although the first 15 months was not a financial success, owing to the variety of circumstances always attendant upon a first year's working, the engineer states that during the last three months they are making a profit. The price paid for gas is 3s. per 1,000 cubic feet, and the works are in the hands of a private company. Owing to the increased demand for heating and power, it is believed the introduction of electricity has not caused any reduction in the gas company's revenue. Coal cost 13s. 6d. a ton in the works, and the consumption is about 1,500 tons per annum. The way the Council got information as to the probable consumers was by circular issued to the residents asking them to state what number of lights they would take. A meeting was also held, at which the scheme was explained to the public. It is only in the principal streets that the arc lights are placed, the other streets being still lighted by gas. Judging from the kind of consumers who have taken the light at Kingston, it is quite clear that the small shopkeepers as well as the large shopkeepers, and small as well as large householders, have thought it worth their while to avail themselves of it. Taken all round, the venture is considered a success of the most encouraging kind, and it is anticipated that early extension will be necessary. The ratable value of the borough is £130,000, the population 30,000, and the rates in the pound altogether 5s. 6d.

Brighton.—At last week's meeting of the Town Council it was reported that at a meeting of the Lighting Committee held on May 20 the electrical engineer stated that the Corporation having decided to instal the larger Babcock and Wilcox boilers, it would now be possible, and greatly to their advantage, to instal one 750-h.p. Willans steam dynamo instead of two smaller ones as at first intended. This would necessitate the lowering of the new engine-room floor, to commence at the boundary of the present engine-room, instead of some 20ft. further south. The committee approved the suggestion, and instructed the surveyor to arrange for the erection of the new building accordingly. At a further meeting of the committee held on June 1 tenders for the supply and erection of arc lamps, switches, etc., were again submitted, and it was resolved to accept the tender of Messrs. Sharp and Kent, of Victoria-street, Westminster, at £2,167. Councillor Stafford proposed the confirmation of these proceedings, and the motion was agreed to without remark. The new pier erected

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by the Brighton and Rottingdean Seashore Electric Railroad Company, has been opened to the public. The new jetty, which has been constructed by the company as part of their tramroad undertaking, which is now rapidly approaching completion, was designed by Mr. St. George Moore, of Victoria-street, Westminster, co-engineer with Mr. Magnus Volk in the laying down of the railway. The plans show a structure 800ft. in length but the portion now erected extends seaward for a length of 300ft. only, having a width of 20ft. opening out to 60ft. at the head for a space of about 40ft. The pier is now connected with the shore by a temporary gangway abutting upon the Gap; but this is presently to be displaced by a sea-wall 26ft high and 300ft. long, the top of which will form a railed promenade 20ft. wide. The effect of this will be to give a much better approach to the pier, and to greatly improve the approach to the beach by the Gap. At the seaward end of the pier, the deck of which is nearly 30ft. above high-water level, a flight of iron steps will communicate with a landing-stage 12ft. above high water and on a level with the electric tramroad cars, which are carried on an elevated framework at a level of 23ft. 9in. off the rails laid along the seashore. The tramroad will not be completed before August.

Glasgow.—The minute of the special sub-committee on the application by the electrical engineer for increase of salary, which was delayed by the Town Council at their previous meeting, was considered at their last meeting. The sub-committee reported that they had "agreed to recommend that Mr. Arnot's salary be increased from £350 to £450 per annum, as from 1st current, subject to the following conditions: (1) That the whole of Mr. Arnot's time is to be devoted primarily to the duties connected with the electric lighting department of the Gas Trust; (2) that in the event of an application being at any time made to the Sub-Committee on Electric Lighting by any of the other committees of the Corporation for the advice or services of Mr. Arnot in connection with any matter under the control of such committee, Mr. Arnot is, with consent of the Sub-Committee on Electric Lighting, to render such advice or service, and that the committee to whom such advice or service is given be charged therefor; and (3) that the increased salary now proposed to be paid to Mr. Arnot is to cover any advice or service he may render to any other committee of the Corporation, as before mentioned." Bailie Burt in moving the adoption of the minute, pointed out that the work in connection with the electric lighting department had been rapidly extended. Mr. Shearer said it was advisable, until the omnibus Bill was passed in Parliament, that words should be inserted to the effect that Mr. Arnot's services should be also available to the Police Board or any of the municipal trusts. This was agreed to. Mr. Jack seconded Bailie Burt's motion. The minute was unanimously confirmed. The Special Committee on the Telephone Service reported that at their meeting on May 1 they had instructed steps to be taken to ascertain the opinions of telephone users in the city as to the inefficiency, etc., of the telephone service in Glasgow, with a view to the result being laid before the Select Committee. Looking to the fact that the Select Committee had received evidence in favour of the telephone company's service, the committee resolved to ask the Select Committee to also receive evidence on the other side, and it was remitted to the chairman and Bailie Chisholm to select two persons whose names might be transmitted to that committee, with a request that they be examined. Deacon-Convener M'Lennan enquired as to who had authorised this action. It seemed to him to be rather hitting below the belt. Bailie Alexander explained that as other municipalities were doing the same thing, the committee thought it desirable that the telephone users should have an opportunity of expressing their opinion as to the efficiency or inefficiency of the service. The minutes were approved.

Tunbridge Wells.—At a meeting of the Town Council, Alderman Stone-Wigg asked the cost of public arc lamps and the number of applications for private lights? Councillor Wood said the question had been asked and answered before. The public lamps would cost £20 per year, and there were now applications for about 1,000 lights, but no doubt they would come in more rapidly when the works started. The Mayor said that was the general experience. People did not instal the light before they wanted it, and with the approach of winter there would probably be a number of further applications. Councillor Saunders asked the chairman of the Lighting Committee if the public lighting would be started immediately the station was open, or whether the private lighting would be started first? Councillor Gower asked if an additional lamp would be placed at the end of Camden-road? Councillor Strange asked if the difficulty with Messrs Burns and Berridge as to the Pantiles had been got over? Councillor Wood replied that the date of turning on the current had not been fixed. Another lamp would be put at the end of Camden-road. The Pantiles difficulty was still under negotiation. Alderman Cronk wished for further information as to the cost of public electric lamps, and whether they were to be kept alight during the whole night, or the same hours as the gas lamps. The Mayor, in reply, said the estimate was based on the fact that the City Company charged £26 per year for the public lamps, but they were lighted one hour before sunset, and were kept alight one hour after sunrise, which was really unnecessary. The Lighting Committee reported that they had held three meetings. Mr. Gallard wrote requesting that arc lamps might be erected on the Boyne Park Estate, but was informed that the committee could not do so until the estate was more developed. The town clerk was instructed to communicate with Mrs. Molyneux Williams's trustees as to placing an electric lamp over the Grosvenor drinking fountain. Messrs. Burn and Berridge wrote that the proposal to lay house service lines across the Pantiles was quite impracticable, and suggesting that a second low-tension main should be laid on the east side of the Pantiles. It was decided to extend the mains along Mount Ephraim to the Grosvenor Fountain, along Calverley-road to Howard's-corner, and through Monson-road at a cost of £630. The expenditure of the new loan of £12,000 was discussed, and Mr. Preece engaged to prepare plans and estimates. Messrs. Delves, Howard, Pelton, and Read attended as a deputation from the gas company and discussed the terms of the new gas contract. There were 55 applications for the post of resident engineer at a salary of £250 per annum, and it was arranged to select a candidate at an early meeting. It was decided to obtain tenders for 20 additional arc lamp-posts, and also to allow customers, if they desired, to purchase their own meters under certain conditions.

Derry.—The Mayor (Alderman Bell) presided at a meeting of the Lighting Committee of the Corporation on Thursday last week, when Alderman Pollock moved that the electrical engineer be instructed to prepare an estimate of the cost of providing private electric lighting. He gave statistics to show that private lighting was a money-making thing in many English and Irish cities and towns. Councillor MacCullagh seconded. A long and angry discussion followed. There was a scene of considerable excitement when Councillor Hastings, as chairman of the Lighting Committee, declared that he would command the engineer to refuse to obey the resolution if it was carried. Five voted for and five against the resolution. The Mayor refused to give a casting vote, and nothing definite was done in the matter. Mr. Christie, the electrical engineer, reported that with regard to the proposed scheme for lighting the Guildhall and clock by electricity, he communicated with the firms who would supply the necessary plant, and asked them if they would take payment of their accounts in instalments. He had received in each case favourable replies. He reminded the committee that for the greater part of the year the staff at the generating station work seven shifts per week, and a large proportion of this is nightwork. It was the general custom in electric lighting stations throughout the country for the men so employed to be allowed a 10 or 14 days' leave with pay. During the next six weeks the men could best be spared, and he (Mr. Christie) asked for authority to grant the holidays sought, by allowing away two at a time as circumstances permitted. A letter was read from Johnson and Phillips, Old Charlton, Kent, stating that they would accept payment for the electric plant, etc., specified for the Guildhall lighting, in three instalments—one-third on delivery, one-third six months after, and one-third 12 months after that. Messrs. Siemens Bros. wrote saying they were willing to accept the offered terms of payment—viz., half-yearly instalments of not less than £40. On the suggestion of the Mayor, the committee authorised the resident engineer to make the arrangements for the holidays for his staff in accordance with the method indicated in his report. Referring to the lighting of the Guildhall clock and main hall by electricity, Councillor Turner said the communication received from Siemens Bros. was very satisfactory. That firm had treated the Corporation very well in the past, and he thought they should not be passed in giving the present order. Councillor MacCullagh said if the work were pushed on and completed, it would be a very nice thing to have the clock and hall lighted for the first time on the arrival of the visitation of the Irish Society. The resident engineer observed that if the orders were placed without delay he considered he would have the work finished before August 2 next. After a few remarks, the Mayor said that a special meeting of the Council would be called to consider the matter. Mr. Christie's report was then approved and recommended to the Council for adoption.

Blackpool.—At a meeting of the Town Council, in reference to the Electric Lighting Committee's minutes, Alderman Buckley and Councillor Hodgson rose at the same moment to make some comment. The Mayor gave the former the first opportunity. Alderman Buckley's question was when the time would expire for the completion of the tramways. Councillor Pearson said that, seeing the alderman was a member of the committee, he had a right to know its secrets and ramifications, but to do so he invited the alderman to attend the meetings more regularly in the future. Alderman Buckley did not care for this evasive answer. It was right that the ratepayers should know when the parliamentary powers ceased, and it was the duty of the chairman of the committee to give a straightforward answer to a question affecting the residents of Lytham-road. Councillor Hodgson wished to know how it was that Mr. Robert Hammond had been appointed consulting engineer to the electricity works, seeing that Mr. J. Hesketh was at present in charge of the works. Was not that gentleman efficient? If he were not, it was time they got someone who was. He found from the minutes that on April 31 £125 was voted to Mr. Hammond, and on May 29 £100, making a total of £225 in two months. This was spending money rather fast—indeed, faster than any gentleman in that room would spend his own money. Some of them had to work much harder than Mr. Hammond had for his money; in fact, he was a rather expensive toy. Councillor Pearson said he was very sorry indeed that he could not give proper answers to everybody in that chamber. His answer in this case must be similar to the one he had given Alderman Buckley: Councillor Hodgson was a party to the arrangement with Mr. Robert Hammond as consulting engineer, and he was astonished that such a question should be preferred when Mr. Hammond's work was being carried out to the letter. When his work was finished his pay would finish, but not before. Alderman Buckley was proceeding to speak, when the Mayor called him to order, and said that he had already spoken on this subject. The minutes were

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then adopted. The Highway Committee recommended that the public urinals and closets opposite West-street should be lighted by the electric light. Councillor Sergenson alluded to the minute of the Finance Committee authorising the engagement of a boy to attend the telephone switchboard at the police station in connection with the Corporation telephone system. From his little experience of the Corporation system, the speaker said, it had been very unsatisfactory indeed. When it was connected with the National Telephone Company it was available to any part of the town; now it was in a perpetual state of disorder and confusion. If he were in order he should propose that the private system be done away with, and some arrangement arrived at with the National Telephone Company. There were enough Corporation officials already—major and minor. Alderman Cardwell said the complaints were that the switchboard was not attended to at the police station. It would be better to give this new arrangement a trial. There was no seconder to the amendment, and the minutes were accordingly confirmed.

The City.—The Commission of Sewers met on Tuesday, when the Streets Committee presented the following important report on the electric light question: "From time to time we have had under consideration the question of lighting the minor streets of the City under the electric lighting contracts entered into by your honourable Court in the years 1890 and 1891. These contracts provide, *inter alia*, that all streets, lanes, and courts other than those described as main thoroughfares shall be lighted by means of 906 incandescent lamps, the prices being fixed at £10 per annum for lamps of 200 watts power and £5 per annum for those of 100 watts, the right being reserved to the Commissioners to change or alter any specified lamps as they may direct. With a view to determine the best method of lighting narrow thoroughfares, experiments were made in Aldermanbury and Basinghall-street with incandescent lamps of these capacities but the result was by no means favourable to this mode of illumination, and a subsequent trial with alternating arc lamps in the latter thoroughfare proved of no practical value. We thereupon instructed Mr. Preece and your electrical inspector to formulate a scheme for lighting the minor streets where possible by arc instead of incandescent lamps, and a survey of the thoroughfares in question was made, and plans were prepared by Mr. Voysey with that object. The City of London Electric Lighting Company, however, having intimated their inability to furnish us with any reliable estimate as to the cost of giving effect to the proposal until further experience has been gained on the subject, we submit a report from the electric inspector, suggesting that certain experiments should be made to illustrate side by side three different methods of illumination, whilst every facility will be afforded to Mr. Voysey by the company to check the actual cost of each system. It is proposed to light Bow-lane and the court leading out of it to Bow churchyard by means of six Sunbeam incandescent bracket lamps, so arranged as to be capable of being switched on and off by the police. Watling-street, Bread-street, Friday-street, and Old Change are to be lighted by means of 11 centrally-hung arc lamps. The thoroughfares selected for the experiments being contiguous will afford the opportunity of practically testing the comparative efficiency and value of the alternating and continuous current systems of arc lighting, as well as of the method of illumination by means of Sunbeam incandescent lamps, and of obtaining information as to the respective costs of running the same, the City of London Electric Lighting Company having agreed to charge only the actual cost to them of the work, which they estimate at about £386, independently of the charge for running the lamps, which your electrical inspector is of opinion will be about £1 per night. We beg to recommend that the proposed experiments be agreed to, and that it be referred back to us to have the same carried out accordingly." Mr. Wallace said he thought, as the hour was late, and several members had left the court, the report should be printed and circulated and its consideration adjourned. Mr. Edwards having seconded the motion, Mr. Berridge agreed to that course being adopted. The report was accordingly postponed and ordered to be printed.

Bolton.—Mr. W. J. B. Clerke, M.I.C.E., has held an enquiry at the Town Hall into an application by the Town Council for sanction to borrow £17,300 for electric lighting purposes. There were present Aldermen Miles, J.P. (chairman of the Gas, Street Lighting, and Electricity Committee), the electrical engineer (Mr. J. H. Rider, M.I.E.E.), and Mr. C. E. Murphy (Messrs. Hinnell and Murphy), architect for the electricity works. The Town Clerk, in dealing with the application, said that in August, 1893, a Local Government Board enquiry was held into an application to borrow £40,000 for the purposes of the installation. At that time evidence was given showing how that money was proposed to be expended, and it was intimated that for the present they would only spend £22,700. As the result of the enquiry, the Local Government Board gave their sanction for the borrowing of £22,700, and reserved their consideration as to the rest of the £40,000 for any future time when the Council were prepared to proceed with the expenditure. The works had been completed, and the supply of current commenced in October last. They had been fairly successful with the undertaking. They had paid their way with the exception of the amount required for the repayment of loans, and that was considered a very fair and satisfactory position for a beginning. Numerous applications were being received for further service in different parts of the town where mains had not been laid, and the Council had come to the conclusion that it was desirable to complete the original scheme, and ask for the remainder of the £40,000. There had been actually spent already more than the £22,700, the extra cost being due to the building. Mr. Murphy gave evidence respecting the works and the cause of the original estimate being exceeded by over £3,000. Great difficulties were also experienced with the foundations. In answer to the inspector, Mr. Rider said the building had been completed for £10,400. The works were sufficient for all estimated purposes. The Inspector pointed out that if £40,000 was originally estimated as the cost of the undertaking, and there had already been an excess of £3,100, it was likely the Corporation might need £43,000. Hadn't the Council at the next meeting better pass a resolution and rectify the application so that there would not have to be a second enquiry? The Town Clerk replied that the Council resolved to apply for the remainder of the £40,000 originally sanctioned, but consideration would be given to the suggestion of the inspector. Mr. Rider said more than £40,000 would be ultimately required. The amount put down in the estimate would not fill the building with boilers, engines, and alternators. There would still be room for more plant. He thought the estimate of £10,250 would meet the cost of the laying of mains for the next 10 years. Roughly speaking, he thought a further sum of £5,000 would be needed. Mr. Alderman Miles observed that the committee considered it advisable to complete the scheme, as the further works were necessary to meet the public requirements. The Inspector: What do you think about the financial success of the undertaking? Will it contribute to the capital outlay? Mr. Alderman Miles: I have no doubt about it. It is difficult to say when the time will arrive, but I believe that in two or three years, or probably less if the requirement is as great as we expect, the undertaking will be a decided success. We have started so well, and I think we may reasonably anticipate much success. The Inspector: I suppose the tradesmen generally are going in for taking it? Alderman Miles: Yes: there is a big demand. In reply to a further question, the Alderman said the Town Hall-square only of the public thoroughfares was lighted by electricity. It was proposed to extend this system of lighting somewhat. There were six or eight large centres, principally at the junction of streets, where electric lamps would probably soon be fixed, but street-lighting generally by electricity was hardly to be expected yet. Mr. Rider asked if the time for the repayment of the loan could not be extended beyond the usual term of 25 years, but the inspector, while promising to enter the matter in his report, held out little hope of any extension. There was no opposition to the application, and the enquiry into the matter closed.

Yarmouth.—Colonel J. O. Hasted, R.E., representing the Local Government Board, held a public enquiry on Thursday last week relative to the application by the Town Council for leave to borrow a further sum of £17,500 for electric lighting. Among those present were Messrs. J. W. Cockrill (borough surveyor), A. H. Preece (for his father, the consulting electrician to the Corporation), W. Vincent (chief assistant to the surveyor), and H. Ranken (electrical engineer in charge of the local station). The borough surveyor explained that the first loan for the electric light was for £15,000, and this was followed by another of £1 500 to make good the deficiencies in the first estimate. Of the present application, £2,000 was for connecting up 150 customers and £15,500 was for extensions to plant. The electric light was started on January 12 last for the supplying of private customers, of whom there were 87. Of these, 75 were connected up and had 4,534 lamps. The power of the existing plant was equal to 4,500 lamps for private lighting, and this was according to the original estimate. Mr. A. H. Preece said that the plant was working up to its maximum capacity, and it was absolutely necessary to increase it. £1,600 was to be spent in buildings, £1,200 for boilers, £4,800 for four steam dynamos, £3 000 for mains, £1,500 for transformers and transforming stations, £250 for switch boards, £2,000 for connecting customers and meters (250 at £8 each), and £1,000 for contingencies. The new estimate was to provide for 9,000 lamps to be alight at one time, and would enable the Corporation to deal with a demand for 14,000 or 15,000 lamps connected with the mains, because the lamps were never all alight at one time. No more arc lighting was to be provided, as no revenue was to be obtained from it. The cost of lighting by gas was less. The cost of 52 arc lamps was £750, and the gas turned off only cost £600. Mr. Peaton asked whether if the Council decided upon a further extension of street lighting new machinery must be laid down, or the existing machinery displaced and other plant substituted. Mr. Preece replied that any additional arc lighting would mean the addition of machinery. The intention was to add the proposed plant as the demand increased. It was intended to lay down two more main cables in the town. At present there were two, one along the parade and the other along the centre of the town through King-street. These had proved too small. They would lay mains along the South-quay into the centre of the town and along Nelson-road, which would supply the customers obtained in those districts. The mains were laid in quadruplicate, two for public and two for private lighting. The Council were going to lay three miles of high-tension cables and two miles of low-tension cables. The houses had in the past been fitted with small transformers, but now it was proposed to group them, and put in a large transformer to each group. These would be erected in underground chambers in the streets. They were gas-tight, and there was no danger. Mr. J. H. Palmer asked whether the transformer stations could not be placed in the road rather than in the pavement in case of there being any danger. There were, he said, constant complaints of the obstruction caused while the workmen were "performing" below, particularly in King-street. The Surveyor replied that in future he would not place any of the stations in thoroughfares. The Inspector asked how much was required immediately. Mr. Preece replied about £1,600. Next winter they hoped to have the

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plant working night and day. The Surveyor stated that the street-lighting cost £770 per annum, and 4,300 lamps nightly meant a revenue of £2,250 from private consumers, while the annual expenditure at the station was £1,600; £760 was received from the Sanitary Authority for the street-lighting, and the light in the Beach Gardens, where oil lamps were formerly used, cost £60 per year. Mr. Preece calculated that repayment of capital and interest now amounted to about £900 a year. The Inspector said that would bring up the total expenses to about £2,600 a year. Mr. Preece: The present income will just clear that. Mr. J. Rogers asked whether the services of the consulting engineer were to be retained, as he was so expensive. The Inspector said this did not come before him. It was a matter for the Town Council. The Surveyor said that on Wednesday applications were received from three customers for 250 lights. The Inspector: How long will the present loans keep the Council going? The Surveyor: Two and a half years. The Inspector: Then you would have to come for further loans? The Surveyor: Yes, but every extension for private consumers would mean fresh profit. The Inspector said that he was satisfied with the evidence. He then proceeded to inspect the plant at the generating station.

PROVISIONAL PATENTS, 1895.

JUNE 1.

10875. **Improvements in means of lighting cigars, cigarettes, and pipes by electricity.** James White Collings and William Friese-Greene, 41, High-street, Weston-super-Mare.

10895. **An improved electric light standard for workshops and the like.** George Stegmann, 41, Meyrick-road, Clapham Junction, London.

10903. **Improvements in or relating to automatic safety devices for electric currents.** James Barns Stone and Samuel Barnes, 323, High Holborn, London.

10929. **Improvements in apparatus for electrolysing chloride solutions.** Eugene Hermite, Edward James Paterson, and Charles Friend Cooper, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18930. **Improvements in apparatus for electrolysing chloride solutions.** Eugene Hermite, Edward James Paterson, and Charles Friend Cooper, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10951. **Improvements in secondary batteries.** Edwin Freund, 2, Lancaster-place, Strand, London.

JUNE 4.

10977. **Improvements in holdfasts for lightning conductors.** Frank H. Starling, Gresham Electrical Works, Nottingham.

11014. **Improvements in electric governors.** Joseph William Myers, 106, Priory-park-road, Kilburn, London.

11016. **Improvements in electrolytic decompositions, and especially in the electrolytic production of bleaching agents and their uses, and in electrodes and apparatus therefor.** Henry Blackman, 55, Chancery-lane, London. (Complete specification.)

11025. **Improvements in apparatus for working railway switches and signals by means of electrical energy.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

11032. **Improvements in secondary batteries or accumulators.** Theodor Eremin, 45, Southampton-buildings, Chancery-lane, London.

11035. **Improvements in electrical signal or time-alarm clocks.** Herman Zeidler, 45, Southampton-buildings, Chancery-lane, London.

JUNE 5.

11085. **Improvements in arc lamps.** Joseph Devonport Finney Andrews, 45, Fulham-park-gardens, Fulham, London.

JUNE 6.

11110. **Improvements in and relating to electric arc lamps.** William Fox and Frederick Samuel Burroughs, 1, Oriel-street, Lower Broughton, Salford.

11153. **Improvements in motor-generator transformers.** Alexander Bewicke Blackburn and Wilfrid L. Spence, 47, Lincoln's-inn-fields, London.

11180. **Improvements in means for protecting pipes, electric cables, and the like laid in the ground.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

11181. **Improvements in switching apparatus for electric circuits.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

JUNE 7.

11222. **Improvements in voltaic batteries.** Desmond Gerald Fitz-Gerald, 53, Chancery-lane, London.

11227. **Improvements in the arrangements for starting alternate-current electromotors.** Galileo Ferraris and Riccardo Arnó, 45, Southampton-buildings, Chancery-lane, London.

11235. **Improvements in electric fire-alarm apparatus.** Edward Jonathan Dale, 4, South-street, Finsbury, London.

JUNE 8.

11266. **Improvements in electric light ceiling roses.** Joseph Devonport Finney Andrews and Edward Jesse Piper, 34, Victoria-street, Westminster.

11279. **Improvements in or connected with locomotives, also applicable to tramcars, electric cars, carriages, and other vehicles.** Ellis Lever, 6, Lord-street, Liverpool.

11283. **Improvements in and relating to electric high and low tension fuse-heads for use in blasting and other purposes.** George Pettinger, 54, Fleet-street, London. (Complete specification.)

11297. **Improvements in or relating to incandescent electric lamps with two or more filaments.** Albert Zobel, 18, Buckingham-street, Strand, London.

11298 **An improved method or process for obtaining metals or metallic alloys by electrolysis.** Edward Jordis, 18, Buckingham-street, Strand, London.

SPECIFICATIONS PUBLISHED.

1891.

12824. **Electric lighting apparatus.** Zanni. (Second edition.)

17324. **Electric lighting in series.** G. J. and G. J. T. J. Parfitt. (Third edition.)

1894.

10917. **Electric safety fuses.** De Ferranti.

11483. **Driving dynamos, etc., by water power.** Liardet.

12817. **Electric incandescent lamps.** Zobel and Buchmüller.

12867. **Telephone cabinets, etc.** Weighill and Moore.

13136. **Submarine telegraph, etc., cables.** Taylor and Dearlove.

13549. **Electric tramways.** Anderson.

13550. **Electric tramways.** Anderson.

15065. **Making electric contact by passage of a railway train.** Tyer.

22965A **Electrically heating metal, etc.** Thompson. (Coffin.)

1895.

2289. **Recording telephonic conversations.** Kingsbury. (Western Electric Company.)

2915. **Alternating-current distributing systems.** Devonshire. (Steinmetz.)

3573 **Telephonic apparatus.** Burchell.

7657. **Secondary batteries.** McDougall and others.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Brush Company, Ordinary	3	2⅝-2¾
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2⅜
—— 4½ Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	15⅜-16½
—— 5 per cent. Debenture Stock	100	133-136
City and South London Railway, Consolidated Ordinary	100	43-45
—— 4 per cent. Debenture Stock	100	131-133
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-3
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	—
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1½-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1½
Elmore's Wire Company	2	1½-1⅝
Fowler-Waring Cables	5	⅛-1½
W. T. Henley's Telegraph Works, Ordinary	10	10-11
—— Preference	10	14-15
—— 4½ per cent. Debentures	100	103-106
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	6¾-7
—— Pref.	—	—
Liverpool Overhead Railway	10	9¾-10
—— Pref.	10	14¾-15½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	⅛-¼
Metropolitan Electric Supply	10	10¾-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	5⅛-5⅞
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅝-6½
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	8-8½
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5¾-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8¾
—— 7 per cent. Pref.	5	8¾-9¼
Swan United Ordinary	3	1⅞-2¼
—— 4½ per cent. Debentures	100	105-108
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7⅜-8½
Yorkshire House-to-House		5¼-5¾

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NOTES.

Personal.—The Académie des Sciences have elected Mr. Newcomb, of Washington, as a foreign associate, in the room of the late Prof. Helmholtz.

A New Insulating Material—Ambroin.—Ambroin has been invented by Herr F. G. Kleinsteuber, of Bavaria, as a substitute for indiarubber, celluloid, horn, ebony, etc. It is manufactured in various colours and in different brands.

Light Railways.—Sir E. Grey informed Mr. Dodd in the House of Commons on Tuesday that information in regard to State aid granted in foreign countries to light railways had been obtained, and would shortly be laid before Parliament.

Proposed Belgrade-Budapest Telephone.—The Servian Ministry of Trade has decided to enter into negotiations with the Hungarian Government with the view of establishing direct telephonic communication between Belgrade and Budapest.

Projected Brussels-The Hague Telephone.—It is announced that the Belgian and Dutch Governments have concluded a convention according to which telephonic communication is to be immediately established between their respective capitals.

Electricity at the Bordeaux Exhibition.—A correspondent of *L'Electricien* complains that of all the sections at the Bordeaux Exhibition that of electricity is farthest removed from completion, and he advises people not to visit the show before July.

Physical Society.—At the meeting to be held on 28th inst. papers will be read on (1) "An Electromagnetic Effect," by Mr. F. W. Bowden; on (2) "Synchronous Motors," by Mr. W. G. Rhodes; and on (3) "The Electrical Properties of Selenium," by Mr. Shelford Bidwell, F.R.S.

The Stuttgart Exhibition, 1896.—Two hundred and ninety-one firms have up to the present announced their intention to take part in the electrotechnical and art industrial exhibition which is to be held in Stuttgart next year, of which number, 157 will make a show in the electric motor section.

Royal Society.—Among the papers read at yesterday's meeting of the society were "The Magnetical Results of the Voyage of H.M.S. 'Penguin,' 1890 93," by Captain Creak, F.R.S.; and "A Dynamical Theory of the Electric and Luminiferous Medium—Part II. Theory of Electrons,' by Prof. J. Larmor, F.R.S.

Telephones at the Baltic Canal Festivities.—Following the example we set in the Spithead roadstead, the German Admiralty made arrangements for establishing telephonic communication between the shore and the German and foreign flagships and Royal yachts on the occasion of the opening of the Baltic Canal.

Society of Arts.—The annual conversazione of this society was held in the South Kensington Museum on Wednesday evening, and a very large number of members and visitors attended. They were received by Sir John Donelly, the chairman of the council, Sir C. W. Kennedy and Sir Westby Percival, members of the council.

Electric Light in a Convent.—The Brothers of Mercy of Trier (Trèves), of Sacred Coat fame, are anxious to have their domicile illuminated by about 350 incandescent lamps and two arc lamps. An engine, they announce, is already on the premises Three synagogues in Frankfort-on-Main are, by the way, being fitted with the electric light.

At Last.—It is now definitely announced that the Berlin municipal authorities have concluded an agreement with Messrs. Siemens and Halske, according to which this firm is to construct an electric overhead railway in the Prussian metropolis. This information reaches us simultaneously with the announcement that the Milan municipal authorities have granted a concession to the Edison Company, in that city, for the conversion of horse-traction tramways into electric lines.

Telegraphy in Warfare.—The Telegraph Department is the one that has best succeeded in distinguishing itself in recent war business, Chitral way, says *Indian Engineering*. The field telegraph has always been kept well in touch with the fighting column. Men who understand something about frontier fighting know that this result represents a large amount of prevision, pluck, and endurance. The latest news from the front in this connection is that a field telegraph office was opened at Ziarat, over the Lowari Pass, on May 5, and one at Ashreth on the 6th.

Water Power in Northern Italy.—Three schemes for utilising water power for electrical purposes are at present under consideration in Northern Italy. The first proposes to turn to account the Toce River, whence it is estimated 18,000 e.h.p. could be obtained for use in Milan, Gallarate, Busto, Castellanze, and Legnano; the second aims at appropriating, for application in Turin and district, the water power of the Cenischia Valley, near Susa, to the extent of 10,000 e.h.p.; while according to the third scheme 3,000 e.h.p. would be procured from the Gressoni Valley, near Biello.

Books Received.—The Electrical Company, Limited, 122, Charing Cross-road, send us "Electrical Transmission and Distribution of Power," a work based upon the results of undertakings carried out by them and their affiliated firms. The book is published by the company. We are in receipt of the July number of the *English Illustrated Magazine*, which maintains its high standard. Also of "Armature Windings of Electric Machines," by Messrs. H. F. Parshall and H. M. Hobart; the publishers are the D'Van Nostrand Company, New York, and Mr. Robert W. Blackwell, 39, Victoria-street, Westminster.

Municipal Engineers.—The annual meeting of the Incorporated Association of Municipal and County Engineers will be held at Halifax on Thursday, Friday, and Saturday, 27th, 28th, and 29th inst.; president, Mr. Edward Rice Sweet Escott, M.I.C.E., borough engineer, Halifax. The members will assemble on Thursday, 27th inst., in the Town Hall. On the Friday a visit will be paid to inspect the gasworks and electricity works under the guidance of Mr. Alderman Brook and Mr. Alderman Robinson, the chairman and vice-chairman of the committee, together with Mr. T. Holgate, the gasworks engineer, Mr. T. P. Wilmhurst, the electrical engineer, and Mr. W. H. D. Horsfall, the architect of the electricity station.

Electric Lamps for Policemen.—At a meeting of the Watching, Lighting, and Fires Committee of Aberdeen Town Council, Bailie Mearns and the Chief Constable were, on the suggestion of Bailie Scott, instructed to enquire as to the cost of providing the night constables with lanterns electrically lighted, instead of the present oil lamps. The committee unanimously took up the idea in anticipation that not only would electric lanterns prove more effective than those at present in use, but that there would be a saving in the cost of upkeep, etc. The sight of an Aberdonian "bobby," who is about as slow naturally as his London *confrère*, trying to capture a runaway thief while impeded with a heavy accumulator, would be enough to make a cat laugh.

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Electric Cranes.—The Southampton Harbour Board on Tuesday last resolved to erect three additional electric cranes, and also to have their own central station instead of taking current from the town. Mr. Aldridge, of 9, Victoria-street, Westminster, was instructed to prepare the necessary plans and specifications for the cranes and station. There are already two three-ton electric cranes at work, and the new cranes will probably comprise one twelve-ton and two two-ton cranes on overhead gantries. Up till now the current has been supplied by the local company at 6d. per unit, and the Board hope to effect a considerable saving by putting down their own plant. This station will supply current for the pier and quay lighting, and for the five cranes when completed.

London Chamber of Commerce.—An extraordinary general meeting of the members of the London Chamber of Commerce will be held in the council-room, Botolph House, Eastcheap, to-day (Friday), at 2.30 p.m., when the subjoined resolution, which was passed at an extraordinary general meeting of the Chamber held on May 21 last, will be submitted for confirmation as a special resolution: "That the articles of association be altered by the addition to Article 22 of the following clause, to be distinguished as Article 22A: 'The council may admit to honorary membership of the Chamber persons distinguished in statesmanship, diplomacy, commerce, or finance, who shall not be required to sign the application mentioned in Article 19 of the articles of association of the Chamber, or to pay any subscription.'"

Boiler Explosions.—In reply to Mr. Holland in the House of Commons on Tuesday, Mr. Bryce said he had no certain information as to the number of boilers in use in the United Kingdom, but assuming it to be between 150,000 and 200,000, the proportion of explosions was now as it was in 1871—about 1 in 2,000 per annum. In 1871 the Select Committee on boiler explosions reported against the introduction of any system of compulsory inspection, one of their reasons being that a great number of the explosions arose from causes independent of and apart from anything that could be prevented by periodical inspection. Having regard to this opinion expressed by the committee, and to the enormous magnitude of the task which would be thrown upon the State were it to undertake the duty of periodically inspecting all boilers, much consideration would be needed before introducing such a Bill as Mr. Holland appeared to contemplate.

The Pacific Cable.—A meeting was held on the 9th ult., at Sydney, in the Chamber of Commerce, in support of the proposal to establish a cable *vid* the Pacific, Mr. W. Friend presiding. There were also present Messrs. J. S. Larke (Canadian commissioner), A. L. Jessop (president, Adelaide Chamber), D. J. M'Lean (Newcastle Chamber), and others. Mr. S. A. Joseph moved the first resolution, as follows: "That this meeting is of opinion that, in the broadest interests of the British Empire, the early establishment of a cable, connecting Australasia and Canada, across the Pacific, and under British control, is a necessity." Mr. J. H. Storey seconded the resolution, which was supported by Mr. Larke, the last-named giving particulars of the scheme. The resolution was carried unanimously, as also was another approving the scheme and urging upon the Government of New South Wales the advisability of communicating with the Imperial Government and the Governments of Canada and Australasia with the object of having an early and searching investigation into its practicability and advantages.

Tramways Institute.—The annual general meeting of the Tramways Institute of Great Britain and Ireland will be held at the Holborn Restaurant, High Holborn, London, on Thursday, 27th inst., at 11 a.m., for the transaction of special and other business as under: (1) adoption of report and accounts for the past year; (2) election of president; (3) election of vice-presidents and executive committee; (4) election of auditors; (5) appointment of quarterly meetings for session 1895-6; (6) reading of papers on the undermentioned subjects and discussion thereon: (*a*) discussion on "Traction Up to Date," with special reference to report to Newcastle Town Council, by Mr. W. G. Laws, M.I.C.E., city engineer; (*b*) "Traction and Lighting by the International Electric Storage Accumulators," by Mr. A. G. New; (*c*) Thwaites and Cawley's System of Electric Haulage," by Mr. George Cawley, M.I.M.E.; (*d*) "Mattison's Hydraulic Brake." Annual dinner at the Holborn Restaurant, at 7 p.m. On Friday, 28th inst., a visit will be paid to the Exhibition of Railway Appliances and Inventions at the Imperial Institute.

A Franco-Egyptian Scheme.—Parisian papers contain particulars of a grandiloquent scheme, mooted by a French engineer, M. Prompt, which proposes to utilise the waters of the Nile with a twofold object—irrigation and the production of motive power. In the first place, M. Prompt would substitute the cultivation of cotton and sugar cane for the growth of cereals, and establish works for treating these articles of commerce. He would then make use of the cataracts of the great river, as the Falls of Niagara have partially been turned to account, for the distribution of electrical energy. A reservoir, to be built at Assouan, to contain 500 million cubic metres of water, would serve for irrigation purposes, and produce at the same time, he avers, a force of 40,000 h.p., which would be used to run 130 cotton-mills, furnishing employment to 40,000 workers, and consuming every year 100,000 tons of cotton, or about half of the production of the country. About 430,000 tons of sugar could, moreover, he estimates, be annually obtained from the additional watered land. And M. Prompt would guarantee to carry out his brilliant idea at a total cost of 40,000,000f., or £1,600,000, which would be made to yield a net yearly revenue of 10 per cent.

German Electro-Chemical Society.—The second annual meeting of the Deutsche Elektrochemische Gesellschaft took place on June 6-8. Prof. Ostwald, of Leipzig, who occupied the chair, delivered an address on "The Seat of E.M.F." He said that modern work—for example, the investigations of Helmholtz, as distinct from the theories of Galvani, Volta, and their successors—showed that electric energy emanated from the chemical process involved in the contact of metals and acids. Dr. Pollak, of Frankfort-on-Main, followed with a paper on "The Charging of Accumulators by Means of Alternating Currents" (see *Electrical Engineer*, p. 616). The discourse of Dr. Jordis, of Munich, on "Analysis by Electrolysis," also excited interest. He recommended, instead of oxalic acid, the use of lactic acid and glycolic acid for electrolytic purposes; for chlorides and nitrates, he observed, give as good metallic deposits as sulphates. Prof. Eilhard-Wiedemann, of Erlangen, spoke of "The Chemical and Optical Effects of Cathode Rays"; and Dr. Fölsing, of Niederlahnstein, referred to his "Electrolytic Tanning Process," by which, he claimed, in from three to six days the heaviest skins could be tanned—skins which hitherto, he said, took a year to dress. Dr. v. Kovalski, of Freiburg, Switzerland, next declaimed on his "New Accumulator" for the lighting of trains, etc., which has been tried upon French railways. Dr. Pollak questioned the novelty of the accumulator, and Dr. v. Kovalski defended its originality, giving further particulars concerning the storage battery. Prof. Ihle, of Leipzig, in conclusion, communicated details

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of some electro-chemical experiments with nitric acid that he had made.

University College of South Wales. — The testing-house, workshop, laboratory, and boiler-house of the engineering department of the University College of South Wales and Monmouthshire have been drawn up on a large scale. The buildings have been designed by Prof. Elliott, the professor of engineering, and the permanent buildings are provided with right-angle roofs, so that a north light is obtained. Messrs. Lattey and Co., Cardiff, were the contractors for the work; Messrs. John William and Sons, Cardiff, being the sub-contractors for the steelwork in the roofs. The boiler is of the water-tube type, and is rated at 76 h.p., but with economical engines it will develop about 150 h.p. It has been supplied by Messrs. Babcock and Wilcox, Limited of Queen Victoria-street, London. The smoke stack is 100ft. high and is constructed of red glazed brick. A high-speed engine, built by Messrs. Willans and Robinson, of Thames Ditton, has been erected in the laboratory, it being the first of four that are required for practical investigations and experiment. It is of 40 h.p., making 527 revolutions a minute and directly driving the dynamos. The smoke-stack is fitted with an elaborate but comparatively inexpensive system of lightning conductors on a principle which is the outcome of the researches of Prof. Oliver Lodge, D.Sc., the conductors being made and erected by Messrs. S. F. Walker and Co., Cardiff. The total cost of the buildings, exclusive of machinery and fittings, electric light installation, etc., has been over £4,000. At the inaugural ceremony on the afternoon of Wednesday last, Mr. T. H. Riches, chairman of the Technical Education Committee, presided.

As Others See Us.— Signor Guido Semenza, an intelligent Italian electrical engineer who recently visited some of our London central stations, has written a really funny account of his experiences while sojourning here. It is so funny that possibly, when they read it, some of the firms who unsuspectingly conducted this *anguis in herbâ* over their works, and gave him full details of their plant, would like to see him again with a different object. To begin with, Sgr. Semenza avers "that England is certainly not one of the nations which are most advanced in electricity." Then he goes on to say that it is especially in regard to the mechanical application of electricity in this country that he has been "disillusioned"—"no novelty, no tendency toward progress." We "use the two-pole dynamo to the almost absolute exclusion of other systems. Multiphase currents have with us only so far made their appearance in the laboratory, and are looked upon much as in other countries navigable balloons are regarded." Our metropolitan central stations are all alike: "a trashy entrance; an obscure alley leading to the back of a pile of buildings; then a covered passage just wide enough to let a coal-cart through; on the left a pile of coal, on the right the boiler-house," etc. Finally, as a parting shot, we are told that "profound observation proves that the conservative English rarely push things to perfection, apparently because they are held back by exigencies antagonistic to progress." But Sgr. Semenza has, after all, a little to say in our favour. He admires the "readiness with which we are abandoning the slow-speed steam-engine and adopting its high-speed rival"; and also our efforts, as "past-masters in steam-engines," to make the dynamo "above all, a simple and strong machine." And we must, we suppose, like Mark Tapley, be thankful for small mercies."

The Shahzada and Electricity.—After having last week inspected the Liverpool Overhead Electric Railway, the Shahzada was so impressed that he made an appointment for the following day to examine the generating station. According to a local paper, the party, which was conducted by Sir W. B. Forwood, Mr. R. Hobson, and Mr. Cottrel, first inspected the boilers. All the explanations were made by Mr. Cottrel, and were interpreted to the Prince by Colonel Talbot. There seemed to be quite an incongruous air about the scene. First, upon looking through the boiler-house entrance, was to be seen the Lord Mayor in his purple robe and cocked hat, standing on some cobbles of coal. Then, down in the basement, right at the very mouths of the boilers, was the Prince and his motley-looking party, most of whom were regarding what they saw with blank astonishment. The most interesting part of the inspection, however, was that made in the generating-house proper. Some of the native suite appeared a trifle timid when they got to close quarters with the moving machinery; but the Shahzada took matters very calmly, and asked innumerable questions, which were answered by Mr. Cottrel through Colonel Talbot. Altogether about half an hour was spent going through these works, and when the inspection was ended, so impressed had the Shahzada become by the wonders of electricity, that he asked Colonel Talbot to inform Mr. Cottrel that he much desired to have some electrical appliances sent over to his home. It is evident from other facts which have come to light that his Highness has at last become fascinated with electricity. He visited the mosque at a late hour on Wednesday, and, after prayer, was taken through the building by Abdullah Quilliam and others. He was conducted to the electrical room, from whence the motive power is supplied for the electric lighting of the building. It was difficult to get him from this place. He tested the small dynamos, and had all kinds of little experiments made, and did not leave the building until eleven o'clock. The local reporter is evidently unaware that there is an electric light station at Cabul.

Mechanical Traction on Roads.—In the House of Commons, on Monday, Mr. Shaw-Lefevre, on rising to ask leave to bring in a Bill to amend the law with respect to the use of locomotives on highways, explained that the Bill only contained one clause, and, was not, he hoped, of a controversial nature. Its object was to exempt carriages propelled by other than horse power from the regulations of the Locomotives Act in cases where they were not used for traction purposes. Hon. members who had recently visited Paris would have observed that there were not an inconsiderable number of carriages propelled by petroleum, gasolene, steam, and in some cases by electricity. In a trial run between Paris and Bordeaux a carriage propelled by petroleum won, having travelled at a rate of 15 miles an hour. These carriages were completely under command, and horses were not frightened by them any more than by the ordinary traffic. The use of these carriages was practically prohibited in this country by the regulations of the Locomotives Act, which was passed with the object of applying mainly to engines used for traction purposes. Under the provisions of that Act, it was necessary that every such locomotive should be in charge of three persons at least—one walking in front, one behind, and one driving—and the engines could not proceed at a greater speed than four miles in the country and two miles in a town, and were also subject to a license of £10 each for every county where they were used. These regulations were totally inapplicable to the light carriages such as he had described as in use in Paris. Under the circumstances, it appeared to him to be reasonable that the House should exempt carriages of that kind from the provisions of the Locomotives Act. They would be subject to the ordinary regulations of other carriages, or to any other regulations that the House might think fit to be made by the Local

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Government Board. He thought that the regulations should be made by that or some other central authority rather than by some local authority, because the necessity for uniformity was so great that it would not, he thought, be well to make these vehicles liable to different regulations by every county. He had hoped to carry the Bill further, and had been in correspondence with the County Councils Association for this purpose; but that association desired further time to consult the local authorities on the subject. He had, therefore, been compelled to postpone the further scope of the measure and to limit it to the one purpose which he had described. Mr. Jeffreys enquired whether these carriages would pay the usual locomotive tax. Mr. Shaw-Lefevre replied that they would not. It was proposed to exempt them from that tax, but to make them pay in the way that ordinary carriages now pay. Colonel Kenyon-Slaney asked what limit of weight the right hon. gentleman proposed to fix for these vehicles. Mr. Shaw-Lefevre said that he had put a limit of two tons. Leave was then given to bring in the Bill, which was read a first time.

Trunk Telephone Charges.—In connection with the subject of new telephone trunk lines from London, these will constitute a part of the general telephonic organisation of the country, and may be used for short distances as well as long ones. The scale laid down by a Treasury minute is 3d. for a conversation of three minutes for any distance not exceeding 20 miles. Over 20 and under 40 miles the charge will be 6d., and 6d. for every additional 40 miles, or part of 40 miles, the only exception being that a small additional charge may be made where a submarine cable is used or any exceptional expense is incurred. The question has been asked whether the telephones of private subscribers will serve for communications over these long distances by the new trunk lines. The Post Office authorities reply that they will, where the line is a double one; but where there is not a complete metallic circuit, and especially where the distance between the subscriber's instrument and the Post Office wires is considerable, working is not likely to be very satisfactory. In this connection Messrs. D. M. Stephenson and Co., of Leith, write: "The Swedish tariff for distances not exceeding 62 miles is 2d.; not exceeding 155 miles, 4d.; not exceeding 375 miles, 6½d. The Swedish Sound ports, although 400 miles from Stockholm, are included in the 6½d. rate. Stockholm subscribers paying annually less than £5 have a right to speak within a radius of 70 kilometres without extra charge, so that on the same basis there ought to be no trunk fee payable by Edinburgh subscribers for speaking to Glasgow and intermediate places. Will you allow us to complete the list of charges you give for trunk conversations from Edinburgh by putting in parallel columns the rates which would be charged for similar service in Sweden?

	Tariff.	
From Edinburgh to	British.	Swedish.
Glasgow	6d.	nil.
Liverpool	2s. 6d.	6½d.
Cardiff.....	4s.	6½d.
London	4s. 6d.	6½d.
Plymouth	5s. 6d.	1s. 1d.

It must be borne in mind that the Swedish system is of the most perfect description, with twin wires throughout, and the most modern transmitters and receivers. The Swedish Government have no greater facilities than ours in regard to wayleaves, and the Swedish operators are better paid than those in this country. The only justification, therefore, for the enormous extra charges to which we are to be subjected is the excessive price—cost plus 10 per cent. instead of cost minus depreciation—which the Government is paying for the telephone company's white elephant; for it is well known that the company's trunk business has been unprofitable, and has been carried on solely for the sake of the great increase it brought of the very profitable local business. It is true that the Post Office system has been established in terms of a Treasury minute of Lord Salisbury's Government of date May 27, 1892; but the present Government will find it hard to get rid of its responsibility for going on with a scheme which is foredoomed to be financially as disastrous as the telegraphs, unless allowance be made for the facts which have been pressed upon its attention since 1892."

Gas and the Electric Light.—In a paper read before the Incorporated Gas Institute at their Edinburgh meeting last week by Mr. William Newbigging, of Manchester, on "The Transfer of Gas and Water Undertakings to Public Authorities," the author said: "The purchasers of such works are, of course, the public authorities, as representing the ratepayers; and they are, naturally, anxious to pay as small a sum as possible for the undertaking. If it is a water undertaking, there is not as much to pick at as is the case with a gas undertaking; and the state of the works, with a hint or two that the purity of the water is not all that it might be, and that an immediate expenditure is necessary, together with any financial misdoings, are about the sum total of the statements made to depreciate the value of the concern. A gas undertaking has usually to bear the brunt of a much more severe attack. Added to the charges above mentioned, it is pointed out that, since the electric light came more generally into use, it has had the effect of lowering the market value of the shares, and consequently the whole value of the undertaking. Also that the recent improvements made in oil lamps and the greater cheapness of oil have made this a more formidable rival than before; that from the facts of the profits depending, to a great extent, on the price of coal, and that in recent years the price of labour has increased, the profits are not likely to be as much in the future as in the past. Such, as a rule, are the arguments used to depreciate the value of the undertaking; and it is necessary to refute them. Has the electric light in any single instance been detrimental to the interests of a gas company? On the contrary, it has stimulated the gas companies to greater efforts; and they have increased their consumption in directions which at one time were hardly dreamt of. I refer more particularly to the increased consumption of gas in the daytime—to the hundred and one purposes to which gas is applied, and where it may now be said to be indispensable. No; the electric light may in some instances have caused the market price of the shares to droop a little, but it has in no way altered the real, substantial value of a well-managed gas concern. The recent improvements in oil lamps (and they were much needed) are to be commended; but the advantage that oil possessed—in that people were able to pay for it as they used it—has been counterbalanced by the introduction of prepayment meters. The enormous demand for these is a proof that people prefer gas to oil if they can pay for it by small instalments. So much for oil. As regards the price of coal and the labour question, these are factors which influence the success of every undertaking, whether railway, gas, or electric light. All these statements are brought forward with a view to reducing the value. A concern burdened with a heavy capital on which maximum dividends are being paid is not able to sell gas or water as cheaply as one with a small capital; and it is the possibility of being in a position to lower the price, amongst other reasons, that tempts a public authority to take steps to acquire such an undertaking. They know that the cheapness of these neces-

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saries—gas and water—is an aid to the prosperity of the town, as it induces people to come to the neighbourhood, not only to reside, but to establish various works where the cheapness of gas and water is a *sine qua non*."

A Unit of Sound.—Mr. Hiram S. Maxim suggests that a standard of sound should be set up. He says: "During the last 20 years many electrical units have been established, and have now gone into common use. For many years we have had units relating to every sort of engineering and scientific question except a unit of sound, and I would like to suggest that some clever experimenter like Prof. Crookes or Prof. Boys should take the matter in hand and establish a convenient unit of sound which would be accepted by the Royal Society of Great Britain and the Board of Trade. If such a unit could be established and accepted by these two bodies, I have no doubt that it would be accepted in the law courts, and might be a ready means of deciding many vexed questions. All owners of electrical plant are liable to be complained of for making a noise. Sometimes it is said that their machinery causes vibrations to the surrounding buildings or grounds; then again that they disturb telephonic communications. Manufacturers are constantly having injunctions served on them for making too much noise when, perhaps, as a matter of fact, the noise is not even audible to those who make the complaint. In many cases, when electrical engineers and those interested in electrical plants have visited the houses of parties who have lodged complaints against electric light stations, it has often been found that the parties making these complaints were willing to swear themselves and to bring any number of witnesses to prove that the noise and jar produced were enough to drive them nearly mad, when, as a matter of fact, the jar and noise were wholly occasioned by the ordinary street traffic, and at the very moment when they pretended to be so much annoyed the electric light plant has not been running at all. Owners of electric and other plant may be, and often are, served with injunctions restraining them from running their works, when in fact the noise complained of is less than that produced by one cab passing along the street. I would suggest, as a starter, that a kind of phonograph should be employed, and that a record should be made on smoked glass which could be put in a magic lantern and greatly enlarged. The amplitude and frequency of the waves would indicate the intensity of the noise produced. For example, suppose a certain record should be made of the noise of the ordinary street traffic, and then another record of the noise of both the street traffic and the disturbance or noise complained of, the two mounted side by side and projected on a large screen would enable the judge to see at a glance how much the noise was increased by the machinery and how much cause there was for complaint, or the noise produced by a factory might be compared with the noise produced by a Salvation Army band, or with other disagreeable sounds which are tolerated by law, at the same distance. As a standard of noise which might be shown in court, I would suggest that shot of a certain size should be dropped, say, from a height of one metre on to some standardised diaphragm, and that the waves should be recorded at, say, five metres from the diaphragm. A record of this artificial noise could be also shown on the screen and at the same time the actual noise recorded produced in court. For telephones, a record of the vibrations set up while the machines were running should be compared with one of those set up when the machines were not running. The comparison of the two would enable the judge—or jury for that matter—to see exactly what the increase in noise actually was."

Society of Engineers.—On the 12th inst. a visit was paid by the Society of Engineers to the Waterloo and City Railway Works, and to the new City of London Brewery. The society have issued the following account of the Waterloo and City Railway: The object of this new electric line is to enable passengers between the London and South-Western Terminus and Waterloo to reach the very heart of the Metropolis with greater ease than is possible with the existing facilities. By this new line passengers will be able to get from Waterloo to a point near the Mansion House, without stoppages, in about four minutes, at an average speed of about 22 miles an hour. To this must be added the time occupied in passing from the South-Western arrival platforms to the subterranean terminus, and from the City terminus to the surface. The departure platform of the electric railway at Waterloo will be about 36ft. below the South-Western platforms, while in the City the depth below the surface will be 65ft. At the latter place lifts will be required, but at Waterloo it is proposed to have easy inclines, with a few stairs at intervals. The line commences at Waterloo at right angles to the existing lines on the southern side of James-street, in the parish of St. Mary, Lambeth, abutting on the Lower-marsh, and, passing under Waterloo Station, curves round to the right, under Cross-street and the South-Eastern Railway viaduct, when it enters the York-road, and still curving to the right, passes under Stamford-street until Hatfield-street is reached. Here it bends to the left on a five-chain curve, and passing under some property at a depth of 56ft. reaches the Surrey side of the river at a point some 500ft. on the up-stream side of Blackfriars Bridge. The river is crossed obliquely, the centre line on the Middlesex side being about 120ft. on the up-stream side of Blackfriars Bridge. From this point the railway bends on a nine-chain curve to the right, and then passes along the centre of Queen Victoria-street to its terminus in the City—opposite the civic residence of the Lord Mayor. The total length of the line will be 1 mile 4 furlongs 6·8 chains, or, in round figures, 1½ miles. From near Hatfield-street to the City both the tunnels will be in the London clay, but from that point towards Waterloo ballast will be encountered. This latter portion of the line will be constructed under compressed air, as large volumes of water will be met with in the ballast. The contract for the construction of the line from Cross-street to the City terminus was let to Messrs. Mowlem and Co. early in June, 1894, and they at once began operations by constructing the stage now so conspicuous an object in the river near Blackfriars Bridge. Here two cast-iron cylindrical shafts were sunk to a point 40ft. below Thames high-water mark, one above each of the tunnels, and below this the shafts were continued by underpinning in brickwork. The shields were then lowered in pieces, put together, and driven forward. Already 1,600ft. of the up, or westernmost tunnel, and 1,400ft. of the down, or easternmost tunnel, have been completed. Both tunnels are now under the Victoria-embankment, and are approaching the Metropolitan District Railway, under which there is a considerable depth of ballast and a small cover of clay over the new tunnels. The Metropolitan District Railway Company required this company to drive the tunnels when passing under, and within 30 yards of their railway, under compressed air, and this is now in progress. The down tunnel towards Waterloo is approaching water-bearing strata, and here also the work is being carried on under compressed air. The haulage of materials to and from the shafts is done by electric locomotives (one in each tunnel), designed and constructed by Messrs. Siemens and Co. The engines and dynamos for the electric lighting of the tunnels have been designed and constructed by Messrs. Paterson and Cooper, of Westminster.

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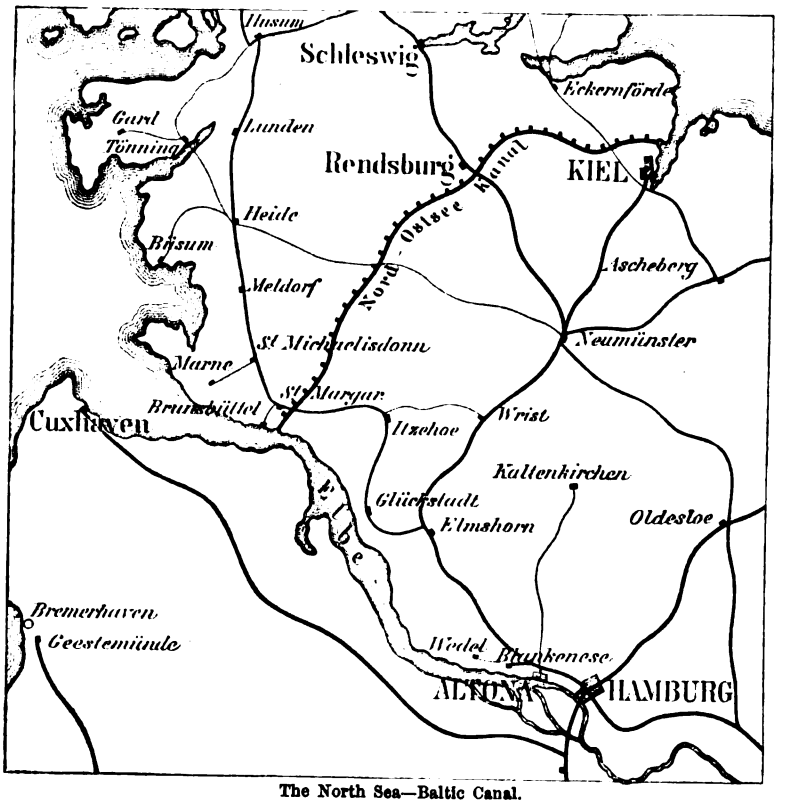
THE ELECTRIC LIGHTING OF THE BALTIC CANAL.

BY HERR C. COERPER, MANAGER OF THE HELIOS COMPANY, COLOGNE.

An undertaking like that of the electric lighting of the Baltic Canal, which is 60 miles in length, has hitherto never been experienced in the electrical industry. True, current has been transmitted to distant points in order to be utilised there for power and lighting purposes—as in the power transmission plant from the River Anio at Tivoli to Rome, a distance of 17 miles, carried out in 1892 by Messrs. Ganz and Co.—but the difficulties have been nothing nearly so great as in the lighting of the whole length of the Baltic Canal. It is easy to take current to a single point and regulate it, but it is difficult to work a large number of lamps placed at considerable distances from each other so that safety and economy may be obtained.



The North Sea—Baltic Canal.

The principles laid down for the scheme, which comprised not only the lighting of the canal but of the locks, harbours, buildings, and harbour lighthouses, were, as has already been stated in the *Electrical Engineer*, as follow: (1) two central stations were to be established, one at Holtenau and one at Brunsbüttel; (2) the stations were to be supplied with the safest economical machinery and apparatus, with an ample reserve; (3) the tension of the current in both stations was to be kept constant whatever the change in the load might be; (4) each lamp was to be independent from the others, so that in the event of a large number of lamps being extinguished there should be no effect on those which remained lighted.

These stipulations have been carried out by the provision at both ends of the canal, at Holtenau and Brünsbuttel, of central machinery-houses for the hydraulic plant operating the locks. Here a large steam supply was installed, which is also available for electric lighting purposes. In the neighbourhood of these the electric generators have been installed.

At each station there are two slow-speed steam-dynamos, made by the Helios Company, of a type which has been largely employed since 1886. The engines run at 85 revolutions per minute, and are each of 200 effective horse-power. The engines are of the horizontal tandem type, with governors by the Maschinenfabrik Augsburg. The cylinders have respectively a diameter of 17in. and 24·5in. and 40in. stroke. At Holtenau surface condensation is proposed, and in the meantime the engines can be connected, if required, with the central condensation plant of the hydraulic station.

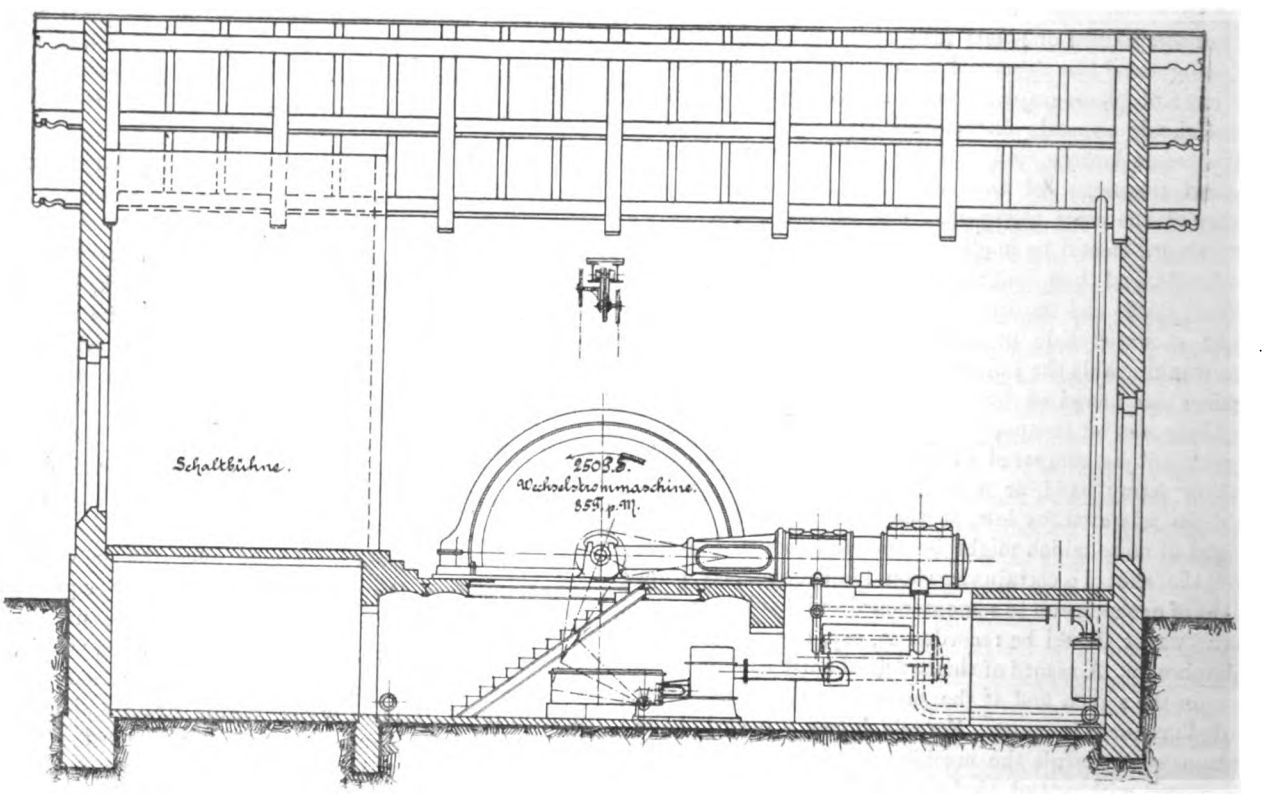


FIG. 1.

Between the two bearings of the steam-engine an alternating-current dynamo is fitted on the shaft, the magnetic field being in one with the flywheel, while the armature ring rests on the beam connecting the two bearings. The

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ring of the flywheel is turned out to receive the 72 magnets made of 20-mil plates. Care has been taken that the formerly-employed ⊥ shape has been dispensed with. The iron has been widened over the bobbins so that

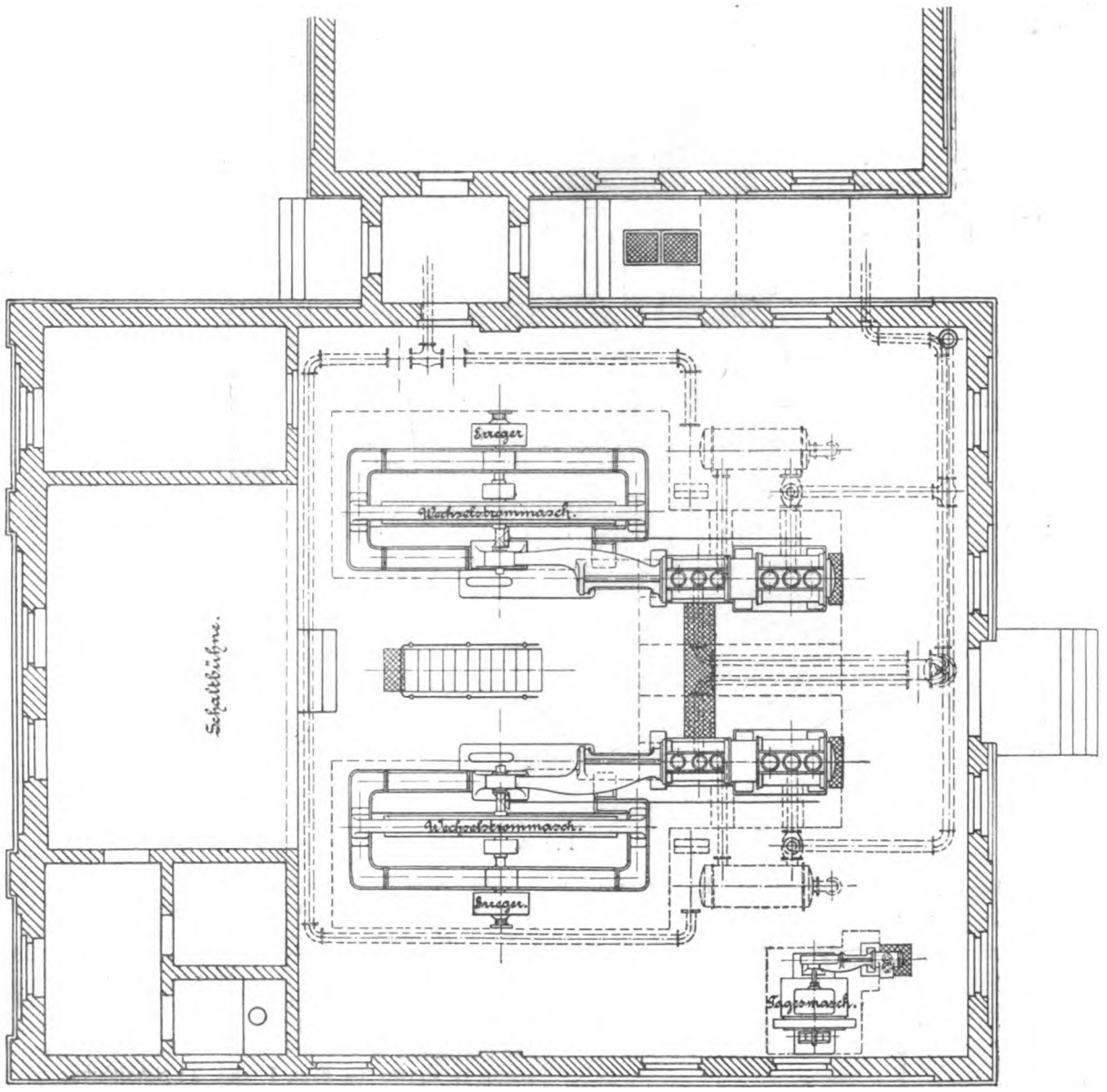

FIG. 2.

that the magnetic circuit is as perfect as possible. The circumferential speed at the surface of the magnets is 2,560ft. per minute, and the frequency of the machine is 51. The armature ring is not only divided on the level of the shaft, so that the upper portion can be lifted off, but the whole ring can be pushed so far sideways that the magnetic field and the armature coils are accessible. In addition, the armature coils are so arranged that they can be drawn out sideways with the armature core by unscrewing four bolts. In Fig. 3 (for which, with the other illustrations, we are indebted to Herr Coerper) is shown an armature segment. It will be seen

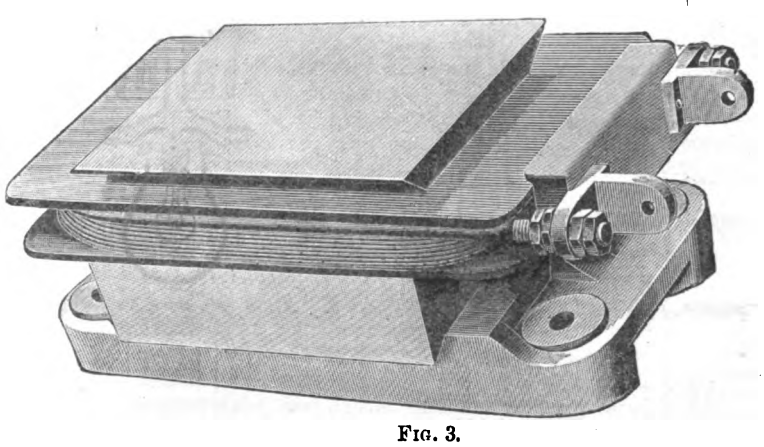

FIG. 3.

segments placed together offer a surface to the magnetic influence only broken by small spaces. The first of this type was supplied by the Helios Company in 1889 for Amsterdam. Experience has shown that with correct measurements a very considerable improvement in the

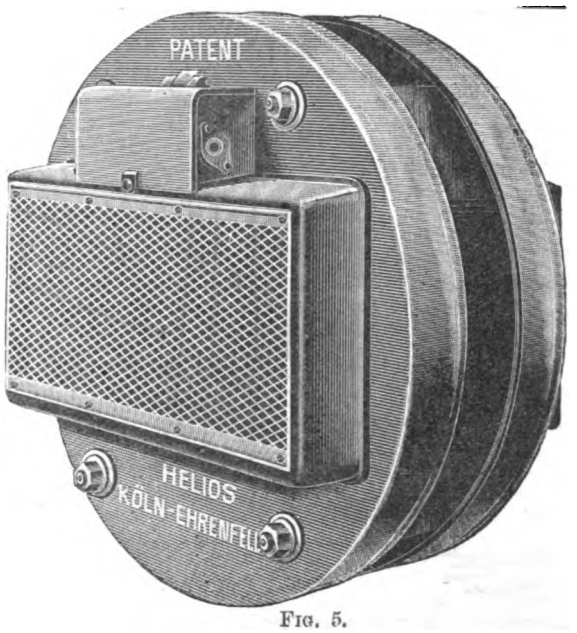

FIG. 5.

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machines has been obtained, without the disadvantages associated with the so-called tunnelled armature. The

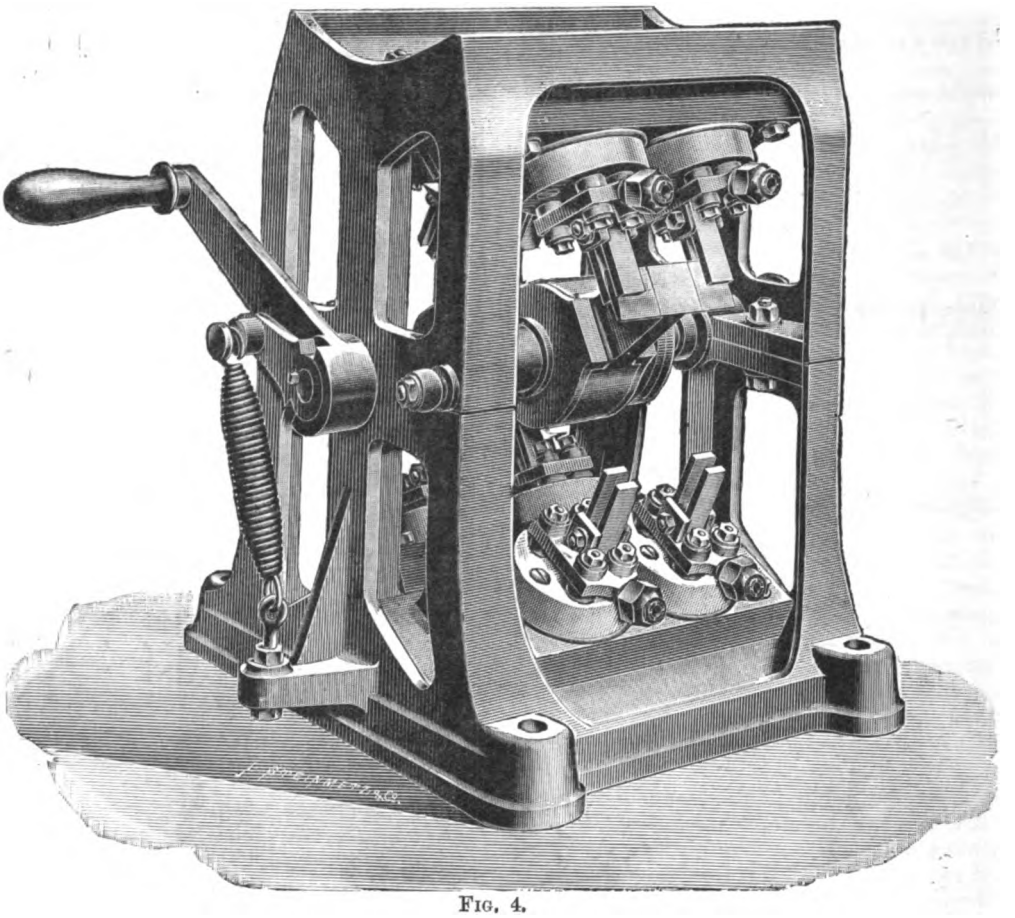

FIG. 4.

pressure of the alternating current at the terminals is 2,000 volts.

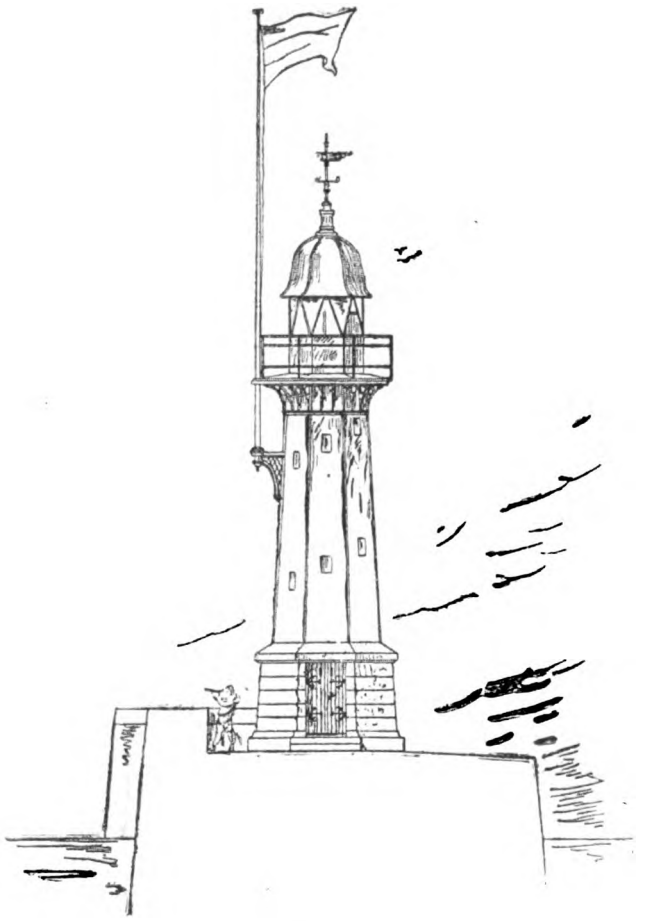

FIG. 7.

As exciter, a four-pole dynamo on the free end of the shaft is employed. The pressure is 120 to 150 volts. The field of the exciter is automatically regulated by a Tesla motor without commutator or collector.

The steam dynamos generate one kilowatt per 12·5 kilogrammes of steam per hour. One steam dynamo is sufficient both at Holtenau and Brunsbüttel for full load, the second forming a complete reserve. At Brunsbüttel an additional small steam dynamo of from 10 h.p. to 12 h.p. is used for lighting the lock chambers during the daytime. It runs at 150 revolutions, and can also be used as a reserve for the excitation of the alternator. The arrangement of the plant is shown in Figs. 1 and 2; *Schaltbühne* being the switching stage, *Wechselstrommaschine* the alternator, *Erreger* the exciting dynamo, and *Tagesmaschine* the day dynamo. The steam-engine at Brunsbüttel has a cylinder

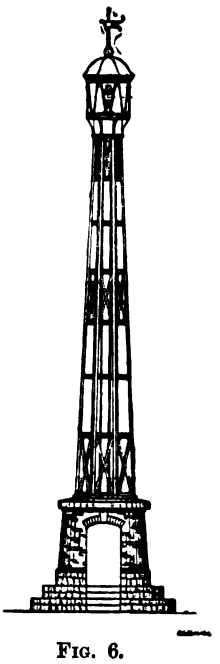

FIG. 6.

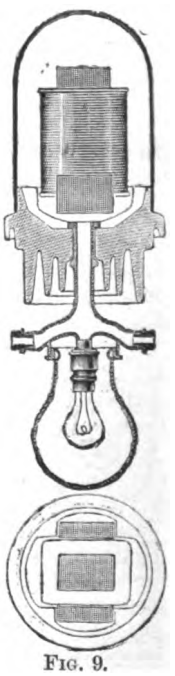

FIG. 9.

of 6in. diameter and 14in. stroke, made by the Maschinenfabrik Augsburg. On the shaft of this is the

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armature of a constant-current dynamo. The magnetic field has four poles.

As regards the switching arrangements, these are different from those carried out by the company at Cologne, Amsterdam, and the projected Dresden station. The apparatus, Fig. 4, are operated by a strong lever, and the switches are all of the double-pole quick-break type. There is a triple insulation—once of porcelain and twice of vulcanised rubber. The whole of the apparatus has been tested to 10,000 volts. When synchronising resistances of asbestos cord covered with nickel wire are employed, which are switched on and off by means of plugs, the difference of phase is shown, not only by two lamps which are fed from a transformer, the double high-pressure current winding of which is fed from both machines, but also by means of a phase indicator.

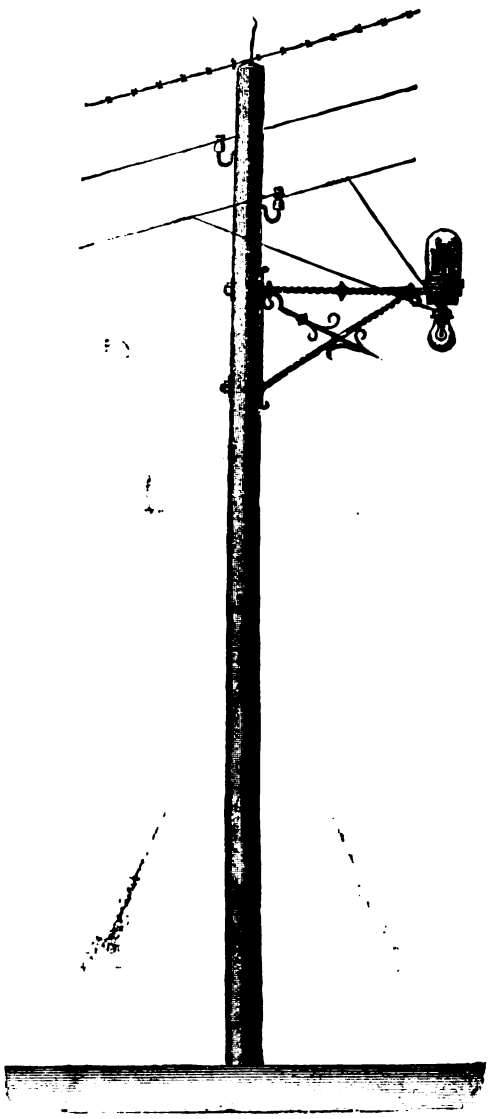

FIG. 8.

This consists of a movable disc in front of two magnet poles energised by both machines. If the phases are synchronous the disc is stationary, but if not, the disc travels in the direction of the machine having higher frequency.

For lighting the boiler and machinery houses, the walls of the lock and the harbour lights, the high-pressure current of 2,000 volts is stepped down to the desired pressure by means of Helios transformers, one of which is shown in Fig. 5. A considerable number of arc and incandescent lamps is used for the purposes above mentioned both at Holtenau and Brunsbüttel. The standards at the locks carry each four 25-c.p. lamps. The conductors are almost all underground, and consist of concentric armoured cables.

At both ends of the canal electric lighthouses have been erected. In Fig. 6 is seen the southern harbour light at Holtenau, while Fig. 7 represents the harbour lights at Brunsbüttel. For lighting the canal, which is 98 kilometres, or, say, 60 miles in length, there are four divisions, one for half the length on either side. Each division has 250 incandescent lamps of 25 c.p., so that the distance between each lamp averages between 600ft. and 700ft. There are lakes, however, on the course of the canal, and these being lighted by gas buoys, and not electrically, the electric lamps are really closer than shown by the average calculation, the distance between them varying from 260ft. to 800ft. Overhead copper conductors (·160in.) are used for the lighting of the canal. At those points where there is a lamp the leads are not cut, but the wire is wound several times round an iron core, so that a quite unbroken metallic circuit is obtained. The incandescent lamp is fed from the ends of the coil so wound.

The iron core and incandescent lamp are so made that only 9 per cent. of the power which is used at the lighting point is lost on the iron core and its windings. Should the incandescent lamp become defective, the whole of the current goes through the windings round the iron core, so that the current is uninterrupted. One-third of the 250 incandescent lamps in each section can be disturbed and out of working order without any regulation of the whole system at the central station being required. The working pressure of each lamp is 25 volts, but on account of the great resistance to be overcome when they are all in series, a pressure of about 7,500 volts has to be maintained at the terminals of the central station. This is obtained by stepping up the 2,000-volt current given by the dynamos. Fig. 8 shows the mast with lamp, which is mounted on a wrought-iron bracket, with the iron core and its windings. In Fig. 9 are represented sections of the lamp. The masts and conductors are protected against lightning by means of barbed wire.

When the installation was started, it was found that the conditions laid down for the same had been satisfactorily fulfilled. The installation works safely, is self-regulating, economical, and each lamp is independent. This satisfactory solution of a difficult problem is of much significance to the electrical industry.

For lighting the rooms at Holtenau used for the festivities at yesterday's inaugural ceremony, current was to be furnished, in addition to that required for lighting the canal and locks, for 165 arc lamps and over 500 incandescent lamps.

In fitting up the electric lighting of the canal, a 12-h.p. electric launch was employed. Its rate of speed is nine miles an hour.

THE ABSOLUTE MEASUREMENT OF ELECTRICAL RESISTANCE.*

BY PROF. J. V. JONES, M.A., B.SC., F.R.S.

(Concluded from page 691.)

We may do much better with such a tuning-fork as described. I place its slits in front of this electric lantern, in which there is a continuous arc; the light falling on the disc has passed through the slits of the vibrating fork, and by varying the rate of revolution we obtain perfectly distinct stationary teeth. Let us suppose that the fork permits the light to pass through it 128 times per second, and that the disc (the teeth on which look stationary) has 14 teeth on it, then one tooth takes the place of the next in 1-128 second, but this corresponds to 1-14th of a revolution, so that one revolution is performed in 14-128 second, and then umber of turns per second is $\frac{128}{14}=9\frac{1}{7}$.

And generally

$$n=\frac{2P}{Q},$$

where P = the pitch of the fork;
n = the number of turns of the disc per second;
Q = the number of teeth in the stationary row.

We may then make the stationariness of a tooth as seen by an observer through the slits a test of the uniformity of the rate of rotation. If a tooth begins to move past a fixed reference wire placed immediately in front of the rotating disc or drum, the observer can at once bring it back by altering the current

* Friday evening discourse delivered at the Royal Institution, May 24, 1895.

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in the motor. So far as I know, this method of measuring a rate of rotation was first used by Lord Rayleigh. The method used by Macleod and Clarke for measuring the pitch of a tuning-fork bears much likeness to it.

If the tuning-fork were itself a reliable time indicator to the degree of accuracy required, we might calculate from its pitch the speed corresponding to stationariness of a given row of teeth. But my experience is that the vibration period of a fork maintained in vibration electrically is not sufficiently constant. If stopped and set going again, it may start with a period different from that of its last performance by several parts in 10,000; no previous determination of the pitch of the fork can therefore be relied on to give us the rate of rotation to that degree of accuracy, though, once started, the fork goes sufficiently uniformly to give us the means of control. The period of a bowed fork does not vary in this fashion, but it is more troublesome to use for the purpose. The constant bowing required takes too much of the attention of the observer. Accordingly, it is necessary to measure the rate of rotation during each run while the galvanometer observations are being made. This may be done telegraphically with great accuracy. The rotating disc is, by means of an eccentric attached to its axle, caused at each revolution to make and break an electric circuit passing through a Bain's electro-chemical telegraph instrument. The standard clock telegraphs seconds to the same instrument. The two records lie side by side on the same tape, and simple counting with careful fractional estimate gives with great precision the mean rate of rotation during the few minutes occupied in taking a set of galvanometer readings.

With this means of measuring the rate of rotation we may, establishing synchronism with a fork in the way I have indicated, find the pitch of the fork.

The following is a set of measurements of the pitch of a bowed fork. I bring it before you as indicating the accuracy both of the synchronising and the time measurement.

TABLE I.

Date. 1892.	Duration of observation, minutes.	Temperature Centigrade, degrees.	Pitch of fork (corrected to 15°·5 C.)
July 16	2	19 67	65·1823
July 17 (i.)	4	19 17	65·1823
July 17 (ii.)	4	19 65	65·1827
July 17 (iii.)	5	20 05	65·1814
July 18 (i.)	4	19 56	65 1809
July 18 (ii.)	4	19 92	65·1823
July 21	4	18·18	65·1812
July 22	4	17 96	65·1831
		Mean	65·1820

Extreme variation from mean is about 1 in 65,000.

§ 11. When I first began working at this method I found it extremely difficult when the disc was in rotation to obtain a steady reading at the galvanometer. My galvanometer is a very sensitive Thomson reflecting galvanometer of about one ohm resistance, made by Elliott Bros., and fitted by my assistant, Mr. Harrison, with a long suspension for the support of the needle by a quartz fibre. When the disc was in uniform rotation, the spot of light roamed continually over 50 or 100 divisions of the scale, and frequently there were sudden jerks of a most embarrassing kind. Readings with a galvanometer so sensitive were, in fact, impossible. (The scale divisions are 40 to the inch, and the scale is about 40in. from the galvanometer).

Now, the E.M.F. in the circuit of the galvanometer when there is no current through the standard coil is due to three causes:

(i.) The cutting of the earth's flux of induction by the radius of the rotating disc. The E.M.F. due to this cause is small in my apparatus owing to the fact that the plane of my disc nearly coincides with the magnetic meridian. For a uniform rate of rotation it is constant.

(ii.) The thermo-electric forces due to the general distribution of temperature in the galvanometer circuit. Changes in this distribution would be gradual, and would not account for the sudden irregular movements of the galvanometer needle.

(iii.) The thermo-electric force at the contact of the external brush with the circumference of the disc. The sudden movements of the needle were obviously due to variations in the thermo-electric force.

I made many experiments with a view of diminishing these changes. I first tried an ordinary phosphor-bronze brush made of a number of layers of thin sheet, and controlled by a spring, brush and disc circumference being well amalgamated. This was not at all successful. Trials were then made with amalgamated copper and amalgamated lead, and with the substitution of a dead-weight pressure for a spring. But no satisfactory result could be obtained. It was noticed, however, that after amalgamation the readings were fairly steady for a short interval, and it seemed likely that if mercury could be continuously supplied to the surface of contact between the brush and disc, the E.M.F. at their contact would be rendered much more constant. This led on to the idea of a brush consisting of a single wire, perforated by a channel through which a constant flow of mercury might be maintained from a cistern of adjustable height, and a brush of this description was made (Fig. 5). Trial showed that our difficulty was at an end. The variations almost disappeared, the sudden jumps quite ceased to trouble us, and the motion of the needle did not extend over more than one or two divisions of the scale for many minutes. A multiplication of such brushes round the circumference would make still further improvement.

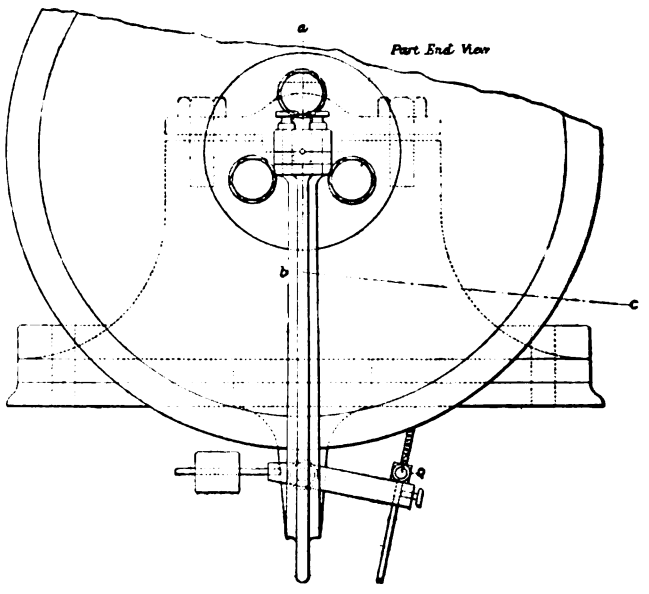

FIG. 5.

§ 12. In measuring a resistance, we have to determine what I have called the equilibrium rate of rotation corresponding to that resistance—*i.e.*, the rate of rotation—such that, on reversing the direction of the current through coil and resistance by the commutator, the reading of the galvanometer is unchanged. Now, it is not very easy to hit this exactly without making a great many trials, and fortunately it is not necessary for us to do so. The current produced in the galvanometer circuit by the difference of the E.M.F.'s at the disc and at the resistance is proportional to that difference; and if the current is small, it is proportional to the scale deflection on reversal. We shall commit no appreciable error therefore, if we are near the equilibrium rate, in assuming that the difference between the equilibrium rate and the actual rate is proportional to the scale deflection on reversal; or, what comes to the same thing, that the difference, $R - Mn$, is proportional to the scale deflection on reversal. If we take four or five rates of rotation near the equilibrium rate, and determine the deflections on reversal corresponding to each, we can by interpolation determine the rate of rotation that would correspond to no deflection—*i.e.*, the equilibrium rate. If, say, we take five such rates, some on one side and some on the other of the equilibrium rate, we get five equations as follows:

$$R - M n_1 = C l_1$$
$$R - M n_2 = C l_2$$
$$R - M n_3 = C l_3$$
$$R - M n_4 = C l_4$$
$$R - M n_5 = C l_5$$

where l_1, l_2, l_3, l_4, l_5 are the deflections corresponding to rates of rotation, n_1, n_2, n_3, n_4, n_5, and C is a constant.

Combining these by the method of least squares, we may readily obtain the most probable values of R and C. If the greatest accuracy is not required, we may content ourselves with two observations—one on one side of the equilibrium rate, and the other on the other side.

The elementary observation in the determination of a resistance with any given apparatus is, then, the determination of scale deflection on current reversal corresponding to a rate of rotation simultaneously measured. To obtain this scale deflection accurately, we must obtain it as a mean of the values given for it by a number of successive reversals succeeding one another as quickly as possible in order to eliminate slight variations in the position of the galvanometer needle due to the slight remaining variations in the thermo-electric force at the external brush contact, and the slight variations of speed that the observer at the tuning-fork has to correct. It is, therefore, best not to wait for the needle to come even approximately to rest after the disturbance due to the induction current on reversal, but to take the readings for the extreme positions in an oscillation, and having previously found the

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coefficient of damping, to calculate the position of rest from these two readings.

Here is a table of an average set of such observations taken during a three minutes' run. The readings with the commutator in one division are denoted by E, and those with the commutator in the other division are denoted by W. The deflections on reversal are given in the column marked W – E.

TABLE II.

E.		W.		E. (calc.)	W. (calc.)	W - E.
·33	+ 19·5	+ 14 5	– 19	– 2·3	– 5·1	– 2·8
						– 3·4
– 28	+ 17	+ 16 5	– 18·5	– 1 7	– 4 0	– 2 3
						– 1·0
28·5	+ 15	+ 15	– 21·5	– 3 0	· 6·4	– 3 4
						– 2 8
28·5	+ 14	+ 17	– 22	– 3 6	– 5 8	– 2 2
						– 2·8
27	+ 14	+ 17	– 22 5	– 3 0	– 6·1	– 3·1
						– 2 8
·29	+ 15	+ 19	– 23 5	– 3 3	– 5·9	– 2·6
						– 3 5
27	+ 15	+ 18 5	– 22 5	– 2 4	– 5 5	– 3 1
						– 2·3
26	+ 13	+ 18	– 22	– 3 2	– 5·4	– 2 2
						– 2·4
28 5	+ 15	+ 18 5	– 22·5	– 3 0	– 5 5	– 2·5
						– 2 0
29 5	+ 15	+ 16 5	– 23	– 3·5	– 6·6	– 3·1
						– 3 5
· 26 5	+ 13·5	+ 22·5	– 24·5	– 3·1	– 5·0	– 1·9
						– 2·5
– 26·5	+ 14 5	+ 19	– 22·5	– 2 5	– 5 3	– 2·8
						– 1·8
– 29 5	+ 15	+ 16·5	– 21	– 3·5	– 5·4	– 1·9
						– 2·9
– 26 5	+ 14·5	+ 18·5	– 21·5	– 2·5	– 4 9	– 2·4
						– 2·1
28·5	+ 15·5	+ 17	– 22	– 2·8	– 5·8	– 3·0
						– 2·6
– 22·5	+ 10·5	+ 22·5	25	– 3·2	– 5·3	– 2·1
						– 2·4
– 26	+ 13·5	+ 18·5	– 22·5	– 2·9	– 5·5	– 2·6
					Mean	– 2·57

Summing up, then, we have during an observation one observer controlling the speed by the tuning-fork method I have described ; another at the galvanometer continually reversing the commutator and calling out the galvanometer readings : at the same time the rate of rotation is being recorded on the tape of the Bain's telegraph instrument under the watchful care of a third ; and a fourth person is required to write down the readings called out from the galvanometer. The run usually lasts one, two, or three minutes according to the degree of accuracy required. The concordance of the results obtained from successive runs in measuring the same resistance is the best test of the success of the combination.

The following is a set of observations of a resistance of about 1-2,000 ohm made in July and August, 1893.

TABLE III.

July 17, morning	·00050016
,, ,, afternoon	·00050016
,, 19, morning	·00050015
Aug. 2, afternoon	·00050020
,, 3, morning	·00050021
,, 4, morning	·00050016
,, ,, afternoon	·00050013
,, 5, morning	·00050019
,, 9, morning	·00050021
,, ,, afternoon	·00050018
Mean	·00050017

The maximum divergence from the mean is ·00000004, or about 1 part in 12,000.

Here is another set made last year in determining the value of the international ohm in absolute units. The results are as follows, the figure in each case giving the value of the international ohm in true ohms :

July 7.—Standard coil carefully adjusted. Three-minute tapes:

·999703
·999761
·999807

Mean..... ·999757

July 9.—No readjustment of standard coil. One-minute tapes :

·999757
·999711
·999683
·999782

Mean..... ·999733

July 10, morning. –Standard coil readjusted. One-minute tapes :

·999734
·999818
·999726

Mean..... ·999759

July 10, afternoon.—No readjustment of standard coil. Three-minute tapes :

·999708
·999742
·999764

Mean..... ·999738

July 11, afternoon.—Standard coil readjusted. Three-minute tapes :

·999693
·999692
·999679

Mean..... ·999688

July 12, morning.—No readjustment of standard coil. Resistance coils reversed :

·999713
·999711
·999692

Mean..... ·999705

July 12, afternoon.—Standard coil readjusted. Resistance coils removed from the mercury-cups and replaced. Three-minute tapes :

·999774
·999787
·999759

Mean..... ·999773

July 13.—Standard coil readjusted. Resistance coils removed from mercury-cups and replaced. Three-minute tapes.

·999847
·999809
·999782
·999842 (morning of the 14th)

Mean..... ·999820

July 14, morning.—Standard coil readjusted. Resistance coils removed and replaced. Three-minute tapes.

·999695
·999692
·999717

Mean..... ·999701

July 14, afternoon.—Standard coil readjusted. Resistance coils removed and replaced. Three-minute tapes.

·999853
·999866
·999875

Mean..... ·999865

These results show that no single observation differs from the mean of a number by more than 1 part in 10,000.

§ 13. We have now to consider the other factor in the resistance—the coefficient of mutual induction of the coil and disc. This depends merely on the dimensions of the coil and disc if they are accurately centred ; and as the adjustment for centre was made in between the successive sets given in the last table, we may take for granted that it can be made with the requisite accuracy. The circumference of the disc is a sufficiently true circle, the disc having been ground true in place. Disc and axle were then removed, and transferred to my Whitworth measuring machine. The measurement of its diameter presented no difficulty. It was easily determined to the 10,000th of an inch.

The mean radius of my coil cannot be determined with the same accuracy, but I believe it is known to the 1,000th of an inch. The coil consists of a single layer of silk-covered wire, wound in a screw thread cut in a brass frame. The silk covering of the wire introduces some uncertainty. It was measured bolted to its stand as in use. Measurements were taken along 18 diameters in the Whitworth machine, with the following results :

Diameter.	Measurement.	Diameter.	Measurement.
0°-180°	21·0898	90°-270°	21·1038
10-190	21·0929	100-280	21·1056
20-200	21·0951	110-290	21·1041
30-210	21·0933	120-300	21·1014
40-220	21·0960	130-310	21·0979
50 230	21·0998	140-320	21·0945
60-240	21·1017	150-330	21·0924
70-250	21·1026	160-340	21·0900
80-260	21·1044	170-350	21·0910

Max., 21·1056
Min., 21·0898
·0158

Mean, 21·09757
t=17° C.

These measures clearly show that the coil is elliptical in

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section, the difference between the major and minor axes being about ·008in., or about 1 part in 1,300. The way in which this fact emerges from the measurements is, however, some indication of the accuracy with which the individual measurements in the machine can be made even in the case of a coil of insulated wire.

My coil, then, is faulty, on account of this ellipticity. I have not yet calculated the possible error due to this cause. It cannot be very great; how much it is only calculation can settle, and the calculation is not without difficulty. But this, after all, is only a question of my apparatus, and does not affect the general question of the possible accuracy of the method. A more solid metal frame might, no doubt, be turned true to the accuracy required, and if so turned might then be measured with the requisite accuracy in the Whitworth machine. A still further improvement may be made by making the coil frame of insulating material, say, paraffined marble, and winding on it naked wire instead of silk-covered wire. The radius might then be measured with certainty to something much better than 1 part in 10,000.

The use of a coil with a single layer of wire, instead of many layers, is a great improvement for the purposes of determining the mean radius. It, of course, necessitated the finding of a new formula for the coefficient of mutual induction. This I obtained by direct integration of the general integral for the case in point—viz., a circle and coaxial helix. The coefficient of mutual induction is given us as a sufficiently converging series involving elliptical or quasi-elliptical integrals.

We may, then, in the result conclude that though I cannot guarantee my own coefficient of mutual induction as correct to 1 part in 10,000 till I have calculated the effect of the coil ellipticity, it lies well within the resources of our mechanical engineers to make a coil and disc free from uncertainty to this degree of accuracy, and if this be so, I am warranted in stating that a resistance can be measured in absolute units to 1 part in 10,000.

Now, in the Order in Council from which I quoted in the early part of my discourse, it is stated that in the use of the ohm standard the limit of accuracy attainable is one-hundredth part of 1 per cent.—*i.e.*, 1 part in 10,000. Hence the Government gains nothing in precision to compensate for the risk it has taken in adopting as unit the resistance of a standard coil which may vary from time to time in consequence of changes in the physical condition of the coil. There is no valid ground left for adopting as ultimate unit any other unit than the absolute unit itself. We have not in our electrical standard legislation given full credit to the mechanical engineer for what he can do for us. He can make a machine that will measure resistance in absolute units with a precision as great as, I might say greater than, that with which the Government is prepared to guarantee its comparisons. Such a machine ought to be at work in the Board of Trade Laboratory in order that there may be opportunity from time to time at regular intervals to measure the Government coil or coils in absolute units. It is necessary that this should be done if we are to be guarded against the perpetual inconvenience of unknown possible changes in the coil the resistance of which is now the legal unit.

§ 14. Such a step would have collateral advantages. It would enable the Board of Trade to certify standards of low electrical resistance. With such a machine, standards of from 1-1,000 to 1-500,000 of an ohm may be measured to nearly the same percentage accuracy. All we have to do in dealing with the very low resistances is to pass a sufficiently large current through them, and shunt the standard coil of the machine. But to enter into details on this point would lead us too far. I must content myself with saying that I believe such a machine is much the best instrument for standardising low electrical resistances, and that accurate standards of low resistance would be of great service both in the laboratory and the workshop.

I have, in conclusion, only to express my obligation to my assistant, Mr. Samuel Harrison, for the great and constant help he has given me in the course of my investigations on this subject.

ELECTRICITY SUPPLY FROM TOWN GAS.*

BY F. H. MEDHURST.

It is with great diffidence that I venture to submit for the consideration of this influential institute a few important questions in connection with the supply of electricity from central generating stations for public and private purposes. It will probably be freely admitted by every member of this society that the electric light has come to stay; and that in every town of even average importance there are a fair and increasing number of persons desirous of having their business or private premises electrically illuminated—even though the cost, in the great majority of cases, be greater, light for light and time for time, of the electric than the gas light.

* Paper read at the annual meeting of the Incorporated Gas Institute at Edinburgh, June 14.

It is no longer necessary to urge, in a paper like the present, the numerous and unique advantages of electric light, because they are now almost as freely recognised by gas engineers as by electricians. But if the proposition that electricity supply from central stations has been established on a thoroughly sound financial basis be not accepted without doubt or question, then I think that the fact that local authorities are everywhere establishing electricity supply works, and that in 1894 these works were in the proportion of 10 to 1 as compared with those started in the same year by companies, must carry conviction to the minds of the most sceptical; for we do not find local authorities in Great Britain recklessly investing public funds in undertakings that have not given unquestionable proof of their lucrative character.

Nevertheless there can be little or no doubt that the number of electricity supply works in existence, and in immediate contemplation, would be greater than is actually the case but for the strenuous opposition which the electric lighting industry has from the commencement sustained from almost all those interested in the maintenance and development of the gas industry. From time to time it has been attempted to pacify this opposition by reminding shareholders in gas companies, and gas engineers and managers, that actual experience has hitherto demonstrated that in towns where central electric lighting stations have been erected, the consumption of gas has actually increased instead of decreased. It has been plausibly, and not altogether unreasonably, asserted that the advent of a public and private supply of electric light has improved the general standard of lighting; and that those who have preferred to retain gas have been forced by sheer competition to add considerably to the number of jets in their shop windows and shops, in order not to be outdone by those in the same line of business who have adopted the new illuminant.

Then, again, I think it must be admitted that heating and cooking by gas have received a great impetus since the advent of the electric light, and, generally speaking, the fact that the managers, directors, and engineers of gas undertakings have been "put on their mettle" owing to competition with what was formerly almost a monopoly, must in some measure account for the apparent paradox that in districts possessing a public and private supply of electricity the consumption of gas has continued to increase.

But to infer from this undoubted fact that the last word has been said with respect to the competition between gas and electricity would, I think, be highly injudicious. My own opinion is most emphatically that the effects heretofore observed, and that I have tried to explain, are merely transient in their nature; and I think that a very little calm consideration must show that to maintain that because hitherto the consumption of gas has not been seriously affected by the use of electricity therefore it never will be prejudicially affected, is to display ignorance or disingenuousness. With respect to my contention that, in the long run, an increased demand for electricity in a particular district must decrease the demand for gas in the same district, I will say at once that if electricity could only be used for lighting I should be of a contrary opinion, because so long as the demand for the electric current be satisfied by a use of the generating plant in the 24 hours equivalent to only an output of the plant for from three to five hours at full load—so long, I say, as electricity supply works continue to suffer from very small load-factors and from very imperfect means of storing electrical energy will it be impossible to sell electricity for less than from 6d. to 8d. per Board of Trade unit; and I do not think that gas companies have much to fear whilst these rates are a necessity. On the other hand, I believe that there are abundant indications tending to show that these prices need not long remain necessary. Cooking by electricity has produced excellent results. At least one London theatre has been heated throughout by electricity; and electric motors are probably the cheapest, most efficient, and most convenient motors for small powers. In a word, I do not think it too much to say that electricity from town mains is capable of accomplishing everything that may be done by town gas, with the almost single exception that electricity will not contaminate the atmosphere we breathe.

Electrical engineers recognise that the cheapening of the electric current produced at central stations depends in a very great measure on the extent to which electricity comes to be used during the day time, and, generally, during the time when the generating plant is not required for lighting purposes. I have purposely gone rather fully into the question of the by-uses of electricity, because it is by their development that electricity will, I believe, before this institute has held many more meetings, be sold for all purposes for from 2d. to 3d. per unit. I admit that I am only prophesying; and it is for you to examine the premises which have led to my conclusions. At all events, it is certain that if the plant at our generating stations could be worked at full load, and without the intervention of electric accumulators, for 20 hours out of the 24, then the electricity produced could be very profitably sold for considerably less than 3d. per unit.

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But if this thing comes to pass—as, rightly or wrongly, I am convinced it will—what will be the effect on the gas undertakings? If the electricity be produced—as is now usually the case—through the intervention of steam-boilers and steam-engines, then I make bold to say the result will be to very seriously cripple at least a great number of the gas undertakings in this country. It is, I fear, too late in the day for gas companies in important towns to apply for electric lighting provisional orders, because in most cases they would be met by a counter-application from the local authority; and the latter would certainly succeed. But in Great Britain, especially in Scotland and the North of England, many of the gas undertakings are in the hands of the local authorities themselves. In some of these towns electricity supply works have been erected by the local authorities; but in every case, with the single exception of Belfast, the dynamos have been driven by steam-engines, though in one or two instances coke breeze—which has formerly been worth little or nothing—has been used for raising steam in the boilers. In these cases forced draught has, of course, been a necessity. No doubt this plan is economical for the present; but what of the future? What of the time when electricity comes to actually, and most seriously, decrease the demand for gas? Then the demand for electricity will be greater than that for gas; and as the demand for gas decreases less breeze will be made, and there will be necessarily less of it to burn in the boilers, so that steam coal will have to be at least partially resorted to.

Hitherto, then, with the single exception of the Corporation of Belfast, no local authority appears to have recognised that there is no great advantage to be derived from founding one kind of lucrative business if that business is to proportionately reduce the profits of an existing and a paying undertaking already in the possession of the ratepayers. In my opinion, there is one way, and one way only, whereby electricity supply works can be so carried on as to permanently benefit, from a commercial standpoint, the gas undertaking. Obviously this is a consummation devoutly to be desired—at least, in those cases where the gas and electricity supply businesses are in the possession of the local authority, or where (if there be such an example) both belong to the same company. In my opinion, the problem is only to be solved on a permanent and sound financial basis by the employment of gas-engines, actuated by town gas, to drive the dynamos. It may, of course, be said that if this plan be adopted we shall be forced to employ secondary batteries and low-tension direct-current distribution, because it is frequently urged that the speed of gas-engines fluctuates too much to render direct driving advisable. Personally, I must dissent from this view, because I have had opportunities of testing the gas-engines of some of the leading makers, with the result that I am convinced of the possibility of manufacturing gas-engines whose momentary variations of speed under sudden differences of load and cyclical variations are no greater than those of a well-governed steam-engine. I admit that, in the case of the gas-engine, an even turning moment with rapidly fluctuating loads is obtained solely by storing up, as it were, a relatively great number of revolutions in the flywheel—*i.e.*, by employing a very heavy flywheel, rendering advisable a substantial outer bearing. The result is, of course, to increase the consumption of gas at all loads, though the increase is especially felt at light loads. Nevertheless, there is a greater margin for improvement in the gas-engine than in the steam-engine; and I trust that before long we shall have gas-engines running, not with fewer explosions at light than at heavy loads, but with weaker explosions, as it will then almost certainly be possible to reduce the heavy gas-engine flywheels, which have attained almost alarming dimensions.

But taking the gas-engine as it is, I propose to try and demonstrate the effect that would be produced in the event of a local authority, owning the gas undertaking, deciding to employ these engines for its electricity supply works. I assume that the electrical system adopted be the alternating high-tension system, with transforming sub-stations. Whether steam-engines and boilers, or gas-engines and no boilers, be employed, the capital outlay on mains and transformers would be the same. In the case of a plant of 180 units, split up into three sets of 60 units (one spare) each, I find that the cost, using Lancashire or water-tube boilers, steam alternators (alternators coupled direct to high-speed steam-engines of the single or double acting type), a feed-water heater, and economiser, is about £600 more than a plant for the same output employing three gas-engines of 110 b.h.p. each, to drive the three alternators with direct-coupled exciters, by means of ropes or belts. In the former instance, I have assumed that the exciter engines are to be coupled direct to their dynamos, but that the exciters are not coupled direct to the alternators. I believe that no adequate advantage would be gained by employing separate gas-engines to drive the exciting dynamos, because I am of opinion that, for various reasons which need not here be discussed, parallel running would not in the case of a gas plant be practicable. But that parallel running of alternators is by no means essential to commercial success, is sufficiently proved by the fact that the Newcastle and District Electric Lighting Company—one of the most successful electricity supply companies in England—has never attempted it.

I do think it unreasonable to count on a saving of about £400 in the buildings and foundations necessary to accommodate the gas plant above mentioned, as compared with the outlay that would be requisite for corresponding steam plant. In the former case neither chimney-shaft nor boiler-house are necessary; whilst in the latter the engine and dynamo room must be rather larger and its foundations more substantial than that for the steam plant. If, then, the total capital saving due to the employment of gas plant be £1,000, and if the local authority borrow at 3 per cent. and set aside 2½ per cent. for redemption of the loan, we have a saving of £55 per annum due to the employment of gas plant. Assume that there be no public electric lighting, but that the equivalent of 6,000 lamps of 8 c.p. and 30 watts be connected to the mains, it is fair to reckon on a yearly consumption of 18 units per lamp. The output would therefore be 108,000 units per annum.

The following table, compiled from the Board of Trade returns, shows the cost of production and distribution per unit delivered to consumers from central stations whose outputs in 1894 varied between 60,000 and 200,000 units. A Board of Trade unit of electricity will maintain an 8-c.p. (30-watt) lamp for 33 hours.

Name of town.	Number of units delivered to consumers.	Costs of production and distribution.				
		Coal.	Oil, waste, water, etc.	Salaries and wages.	Repairs and maintenance.	Total.
	d.	d.	d.	d.	d.	d.
Aberdeen	65,012	0·65	0·21	0·85	0·07	1·78
Hanley	65,871	0·79	0·23	0·74	0·38	2·14
Huddersfield..	156,169	0·64	0·02	1·08	0·11	1·85
Taunton	100,495	1·95	0·48	0·79	0·32	3·54
Northampton.	59,474	1·51	0·20	1·55	0·31	3·57
Scarborough..	86,594	1·87	0·13	1·57	0·70	4·27
Oxford	157,257	0·65	0·05	0·92	0·58	2·20
Sheffield	192.220	1·00	0·14	1·20	0·42	2·76
Average ...	110,386	1·13	0·18	1·09	0·36	2·76

As the average output of the stations named is 110,386 units, I think we may take the average costs of production as representing what might reasonably be expected to follow the completion of such an installation as I have imagined, using steam plant, and designed so as to economically meet the requirements of the case.

Now we have to consider what are the costs of production under the four separate heads mentioned in the table, and what the total cost of production would be if the steam plant were replaced by gas plant. It is well known that gas-engines of 100 b.h.p. and upwards are now made to consume not more than 20 cubic feet of town gas per horse-power per hour at full load. But, unfortunately, the conditions of electricity supply are such that the engines would, for the most part, be working much under full load; and I should not anticipate an average consumption of gas of less than 80 cubic feet per unit sold to consumers, taking into account the trying conditions under which the engines would be working. Now, I am informed, on excellent authority, that 1s. 2d. is a fair price to allow as the cost of producing 1,000 cubic feet of gas, including interest on capital expended on the works (but not on mains), and also cost of labour and material. I am assuming that the town has a population of about 50,000; that the electricity supply works are erected at the gasworks; and that the latter are well designed and efficiently managed. The cost of production must vary between fairly wide limits; but it is necessary to assume a definite figure for the purposes of this paper, and those engineers who know that their costs are lower or higher can make the necessary deductions for themselves. But, allowing the above assumptions, the cost of gas per unit sold to consumers works out at 1·12d. per unit. In the case of the steam plant, the average cost of coal was 1·13d., and the highest 1·95d. Oil, waste, water, and engine-room stores would probably be about equal in both cases. I should expect salaries and wages to be rather less in the case of gas than of steam plant, because in the former the wages of stokers will be saved, and the gas engineer and manager may, with a little technical assistance, manage the electricity supply works as well. Repairs and maintenance will, most likely, cost somewhat more for a gas than a steam plant, though the difference must be small. The saving in salaries and wages would probably rather more than cover the extra cost of repairs and maintenance. The net result, then, would be that the costs of production would most likely be almost identical in both cases; whereas the advantages, in point of view of decreased capital expenditure, and hence of interest and sinking fund, appear to me to be decidedly in favour of the gas plant.

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BOUND VOLUMES.

Vol. XIV. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers or binding can be obtained, price 2s.

THE LAMP INDUSTRY.

The inspection of a new, or comparatively new lamp factory, naturally leads to a consideration of the present position of the incandescent lamp industry. History tells us that the incandescent lamp manufacture was for some years a monopoly, and justly so, in the hands of the patentees, or in those of a company formed under their auspices. We have never been amongst those who begrudge a patentee a full and ample remuneration for the outcome of his experimental researches. The man who makes a utilitarian discovery is a benefactor to his kind; he often, as in this particular case, is the means of starting and developing quite a new industry, and when thousands, if not millions, benefit by his labours he should not lack appreciation and due reward. According to the law of the land, the monopoly of the patentee ceases after a certain number of years, and he is supposed, as the Americans would say, to make his pile during that period. It is certain, however, that as soon as a patent of this kind runs out competition will begin, and this has been the ordinary course with the incandescent lamp. Towards the close of the period during which the patent lasted promises of cheaper lamps were made on every hand, and as soon as the patent lapsed, such lamps were put upon the market. One question may now be asked, for sufficient time has elapsed to provide an answer. It is this: Are the cheap lamps really cheap and satisfactory? We are inclined to answer this question in the negative. Many of the cheap lamps have been found to be failures, and purchasers have found in the end that a dearer lamp would really have been more economical. One reason for this is not far to seek, and we may be pardoned for calling attention to it. In any manufacturing process of a delicate nature, it is impossible to so organise the manufacture that each several product is perfect; hence the production of what may be termed wasters. A well-conducted factory—one whose owners seek constant business, repeat orders, and a good reputation—condemns these wasters, not one of which ever wilfully leaves the factory. The destruction of these wasters increases the prime cost of the perfect product. Take this case of incandescent lamps, and suppose that 50 per cent. of the lamps upon completion and testing are found imperfect, then for every hundred lamps made only fifty ought to be sold—the remainder should be destroyed. Of course, this percentage of wasters is probably too high; but if we were to indicate that one-third of the lamps made were imperfect, we should not be far from the mark. Now, if a factory, instead of carefully testing and destroying wasters, is careless and allows them to mix with perfect lamps, the result is a lesser prime cost on the books, and this permits selling at a lower price. It may be argued that, so far as the user is concerned, it does not really matter if he pays, say, a shilling per lamp and loses one in three, or if he pays one shilling and sixpence per lamp and loses none. From a theoretic monetary point of view, perhaps, there is no difference, but from a business

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point of view there is a great difference. The purchaser or the purchaser's clients are disgusted at finding so many bad specimens; and as a matter of practice, in contradistinction to theory, a number of bad lamps upon a circuit do lead to greater cost, and may lead to the destruction of good lamps. The tests of lamps for economy are exceedingly interesting, but this is not the moral we have to inculcate here. We have rather to insist upon purchasers being cautious in buying so-called cheap lamps. The Edison-Swan Company before the expiration of the monopoly had reached a certain excellence of manufacture, and their productions might be taken as a standard. They naturally lowered their prices, while retaining this excellence; hence buyers had some clue as to what might be considered good and what might be looked upon as inferior. If other makers put into the market lamps not inferior to those of this standard at a lower price, that is a legitimate method of competition against which we have no word to say; but if prices are lowered because an inferior article is to be sold, then the purchasing public must suffer. The reputation of a firm is of the utmost importance in business matters of this kind. The trade can and ought to speak positively to its clients, and refuse its patronage to any doubtful products. They know—what the general public do not and cannot know—whether the goods offered are by a firm possessing the necessary knowledge and experience to turn out good work; and if they are satisfied in this respect, there is no objection to recommending the articles offered. Still, dealing with this special question of incandescent lamps, it is well known that the experience and knowledge necessary for the production of good specimens is spread over a limited number. The processes are not all patents—some are trade secrets, and a lack of knowledge about these secrets leads to the production of an inferior article. Here, again, the trade has a grand opportunity of exercising a precautionary discretion and hesitancy in recommending aught that fails to meet their demands in this direction. Briefly, then, we say there should be a recognised standard of excellence, the ability to produce lamps of this standard is in the hands of but few, that firms having a good reputation will not offer products below such standard, and it is wise and economical in the long run to deal with such firms rather than to purchase because of initial cheapness.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COST OF PRIVATE LIGHTING.

SIR,—I have had my attention drawn to extracts from my report and tests of private generating plant at the Olympia which appeared in your issue of the 14th inst., also your editorial comments thereon.

In reply, permit me to thank you for your remarks as to the usefulness of such information, and at the same time state that the estimated costs which are given were not embodied in my report, but have been deduced by the contractors.

Engineering of June 29, 1894, contains a series of comparative tests and costs of private generating plants compiled by the writer, and in which the annual cost of maintenance, etc., is taken from actual working.—Yours, etc.,

THOS. HANNING.

Newcastle-on-Tyne, June 19, 1895.

"HUNNINGSCONE" MICROPHONE TRANSMITTER.
(DECKERT PATENT No. 21,565.)

SIR,—As it has come to our knowledge that certain manufacturers of microphone transmitters are adopting the name of our transmitter known as the "Hunningscone," and are advertising their own wares under this title, with the result that some of our customers have been thereby imposed upon, we beg to offer the following explanation: We are the originators of the name "Hunningscone" as a name for Hunnings transmitter, and that name was suggested by the fact that the internal construction of our transmitter necessitated the use of a number of cones or pyramids arranged in a peculiar manner, to which is due (in conjunction with other details) the excellent effects obtained. This transmitter is manufactured under the Deckert patents, and is the same as now used in large quantities by the General Post Office on their long lines, including the trunk lines recently opened between London, Glasgow, and Dublin, and is also universally adopted by the National Telephone Company. Intending purchasers therefore would do well to be quite sure that they are obtaining the genuine article, manufactured to the Deckert patent specification, otherwise they are not obtaining the original "Hunningscone," but something which must necessarily be inferior, or the manufacturers would not be pushed to such straits as to purloin a title for it. At the same time it speaks well for our transmitter that trade competitors should, as a guarantee of excellence, advertise their supplies under titles which have appeared in our catalogue for the last three years.—Yours, etc.,

THE GENERAL ELECTRIC COMPANY, LIMITED.
(Max Binswanger, Director.)

London, E.C., June 18, 1895.

DUBLIN TRAMWAYS.

SIR,—Mr. Stephen Sellon wriggles beautifully. As he is evidently a wordy letter-writer only, and produces no facts, I must now decline, until he has done so, to further discuss the matter with him.—Yours, etc.,

JAMES L. OWEN.

120, Colmore-row, Birmingham, June 15, 1895.

CITY AND GUILDS EXAMINATION.

We have duly received a number of papers in answer to our announcement of May 10. These papers have been sent to the gentleman who has undertaken their examination, and his award will be made as quickly as possible.

THE ROBERTSON INCANDESCENT LAMP.

When the electric light as produced by an arc lamp demonstrated to the public at large the practicability of its adoption as an artificial light, it was apparent to the most ignorant that its sphere of usefulness was limited. But in 1878 the irrepressible journalist who delights in impossible science, flooded the English papers with an account of an American invention whereby the electric light may be sub-divided to infinity, exactly as obtains in the case of gas installations. Upon this bare assumption a panic ensued in the gas market, and £100 shares which were worth £188 fell rapidly to £135. This *ignis fatuus* was but an experimental lamp made by Edison, in which a loop of platinum in vacua was rendered incandescent by the passage of an electric current. But Mr. Swan, an English scientist, had already for 20 years been experimenting with true carbon filaments, and in 1877, in conjunction with Mr. Stearn (a gentlemen whose original researches in the production of high vacua rendered such lamps possible), a

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number of lamps were made with filaments of carbonised cardboard. As a matter of history, therefore, the incandescent electric lamp in its practical form is essentially a British invention, both as regards primary inception and evolution. Platinum, although sufficiently illustrative from an experimental point of view, is not suitable for a practical lamp. Until the publication of the Swan-Stearn patent nothing was done in America respecting the use of carbon for filaments, Mr. Edison having in the meantime devoted all his energies to the perfection of the platinum filament. But upon the publication of the British patent, platinum was cast aside, and the fauna and flora of the whole world ransacked to produce a carbon. As a matter of fact, neither Mr. Swan or Mr. Edison have any claim to the use of carbon and vacuum, singly or combined. They used a finer thread of carbon than previous experimenters, who doubtless had been limited in this matter by the extreme difficulty of procuring thin carbon rods, and, of course, a good vacuum was an essential. M. Gobard, in 1838, published a monograph on the use of thin carbon as a conductor in vacuum, and the incandescence of carbon in vacuum was patented by King in 1845. The real improvements, therefore, consist in the modes of obtaining a "carbon wire," and in the structural details of the lamp itself. It is a remarkable fact that Edison and Swan both claim a definite principle in producing the carbon filament. This procedure is, in law, fallacious. But whatever benefit attaches to priority, Swan is an Englishman, and the British nation collectively claim it as their own. The courts of law decided differently at the termination of the famous trial, and any intelligent person, upon carefully studying without prejudice, the case as presented, cannot fail to be astounded at the result. The final effect was the establishment of a monopoly, which practically checked the progress of the industry until 1893, when the expiry of the patents opened up business. By this time, however, the foreign manufacturers had the lead, and poured their goods into the English market.

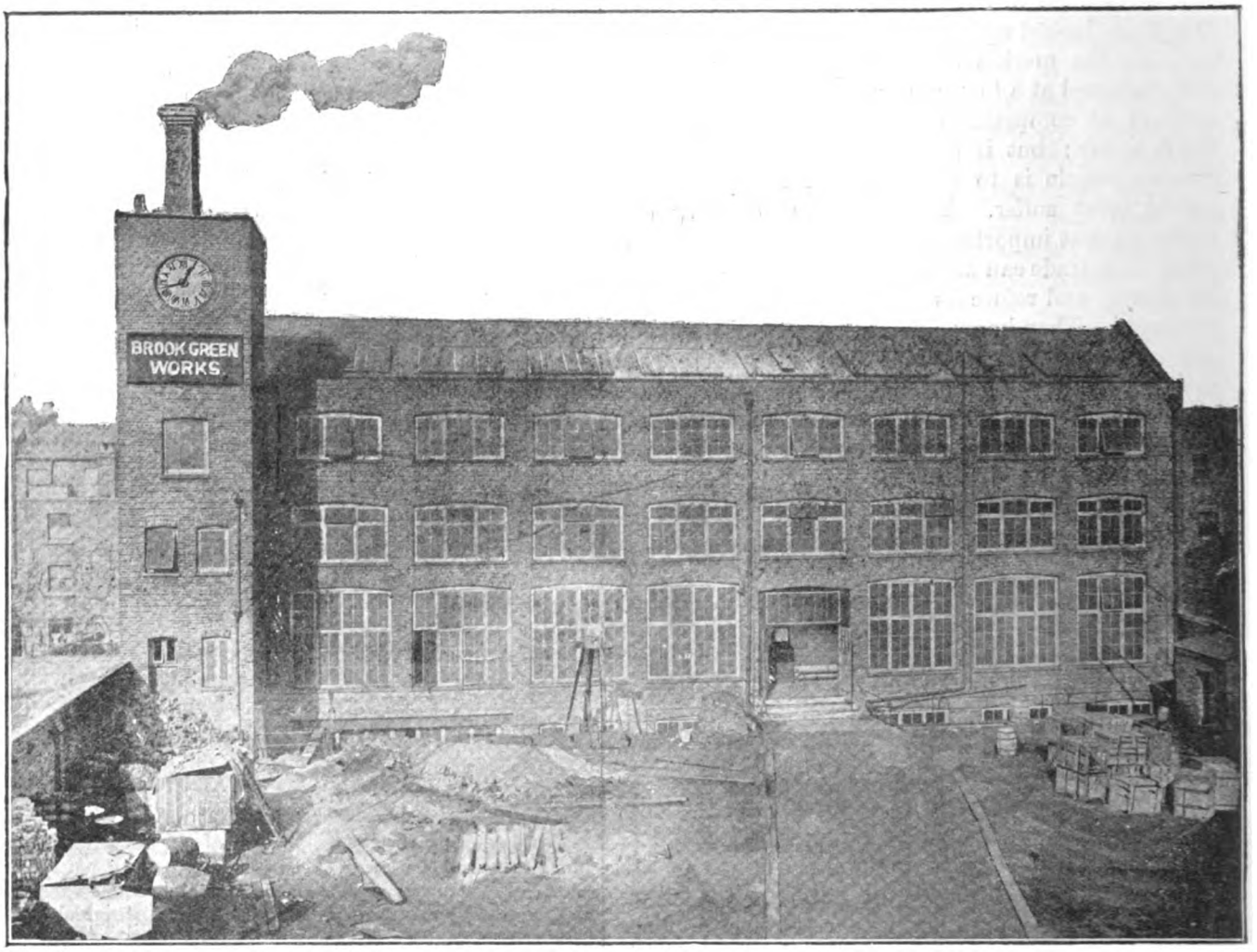

FIG. 1.—The Works of the Incandescent Electric Lamp Company at Brook-green, Hammersmith.

The English makers of incandescent lamps had in the past been crushed one by one, and the whole trained labour been gathered into the shops of the monopolising firm. It follows that individual effort had been stifled except in those gentlemen holding good positions in the one remaining lamp-making firm. So, on the expiration of the master patent in 1893, the technical knowledge in England on the subject was extremely limited. The continental makers had, on the other hand, enjoyed freedom of investigation and an extended market, so that they were ready to send lamps into our country at a very low rate.

It is needless to state that many of the lamps thus thrust on the public were, on account of their bad qualities, unworthy to receive the slightest support. After experience with the good lamps hitherto used by compulsion, the public had lost their keen powers of discrimination, and hence were and are deceived. The Incandescent Electric Lamp Company, Limited, was then started, and set about to remedy the evil, and to endeavour to resuscitate an English industry hitherto repressed. The first thing to be considered was to produce a lamp which, while being in points of efficiency and reliability the best on the market, at the same time could compete in price with the imported lamps. They selected the "Robertson" lamp, the distinguishing feature of which is the constituence of the carbon conductor, which, instead of being filamentous from the first stage of its manufacture, does not become so until several processes are carried through. The carbon is precipitated from a solution, and as a semi-fluid is ejected under pressure through orifices, the sizes of which are determined by the requirements of the lamps.

The company were fortunate in securing the services of the inventor, Mr. C. J. Robertson, as general manager, a gentleman who commenced his experience of incandescent lamp manufacture by holding an important technical position in the Lane-Fox department of the Anglo-American Brush Company in 1881. Since then he has unceasingly followed up the practical manufacture of incandescent lamps

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at home and abroad. Bringing such an experience, combined with a thoroughly technical and practical knowledge of his speciality in all its details, Mr. Robertson, under the auspices of the company, vindicated the home industry, and showed that we can hold our own in spite of the advantages of the foreigner in the past. The works, which our representative visited recently, are situated at Brook Green, in the West Kensington district of London. A plant capable of turning out 4,000 lamps per day is now at work, and there is ample area available to admit of this output being doubled as the demand increases.

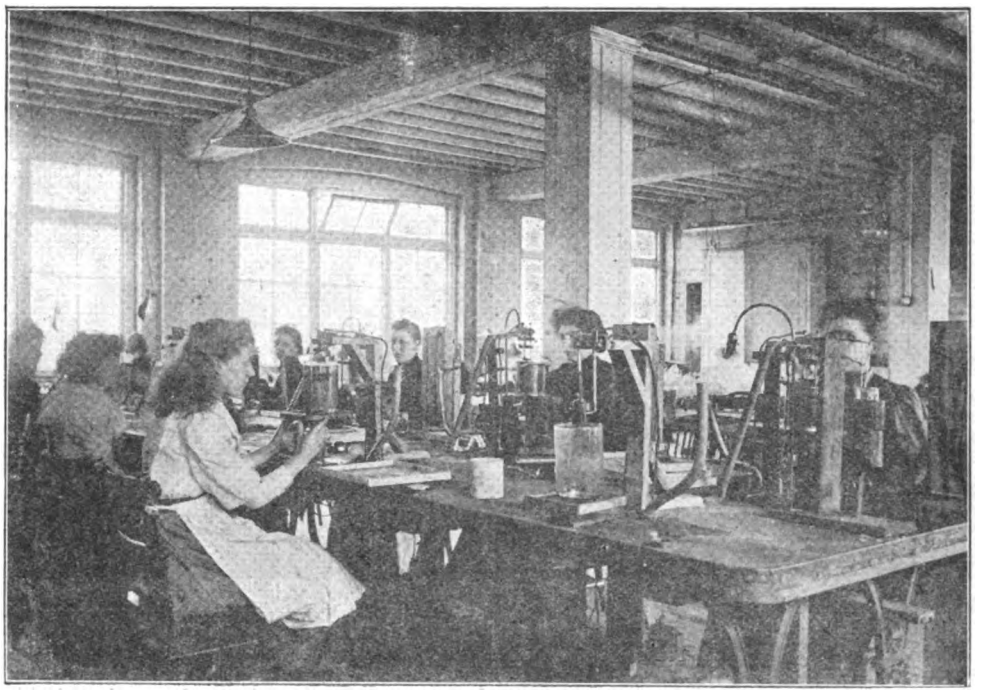

FIG. 2.—View of the Filament Mounting Room, showing Apparatus for Cementing the Junction of the Carbon Filament to the Platinu Wire.

The greatest initial difficulty to be overcome was the education of the hands, for the company determined to employ British labour, and such as had had previous experience in lamp making were used only to the obsolete systems. Therefore an expensive and tedious course of training had to be undertaken before the staff became proficient.

At present about 150 hands are regularly employed in the factory on the various operations connected with the lamp manufacture. The whole of the workrooms are airy, and in most cases they are well lighted. The exception to this last clause are the glass-blowers' rooms and the photometric rooms, where good light would naturally not be wanted. The most of the work is piecework, but the girls, who form the bulk of the staff, can and do earn salaries ranging from 12s. to 24s. per week in the ordinary departments, special hands receiving more. Our representative was struck with the interest shown by them in their work, and our illustration will give a good idea of the pleasing appearance of the staff generally. The details of the construction of the Robertson lamp are so numerous that it is impossible to do more than give a brief outline of the various operations. The raw material enters at the ground floor and gradually ascends; the finished lamps, after being packed, are let down through a tubular fire-escape into the carts standing below. We understand that on emergencies the canvas tube so used is capable of taking the members of the staff, and that all have been down it at least once.

FIG. 3.—Filament Mounting in Various Stages.

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Commencing our description at the lower floors, in the basements is placed the motive power for supplying the whole factory, consisting of engines, dynamos, and alter

a fibrous nature, but is prepared from a solution containing carbon, from which the carbon is precipitated. This semi-fluid precipitate is then squirted

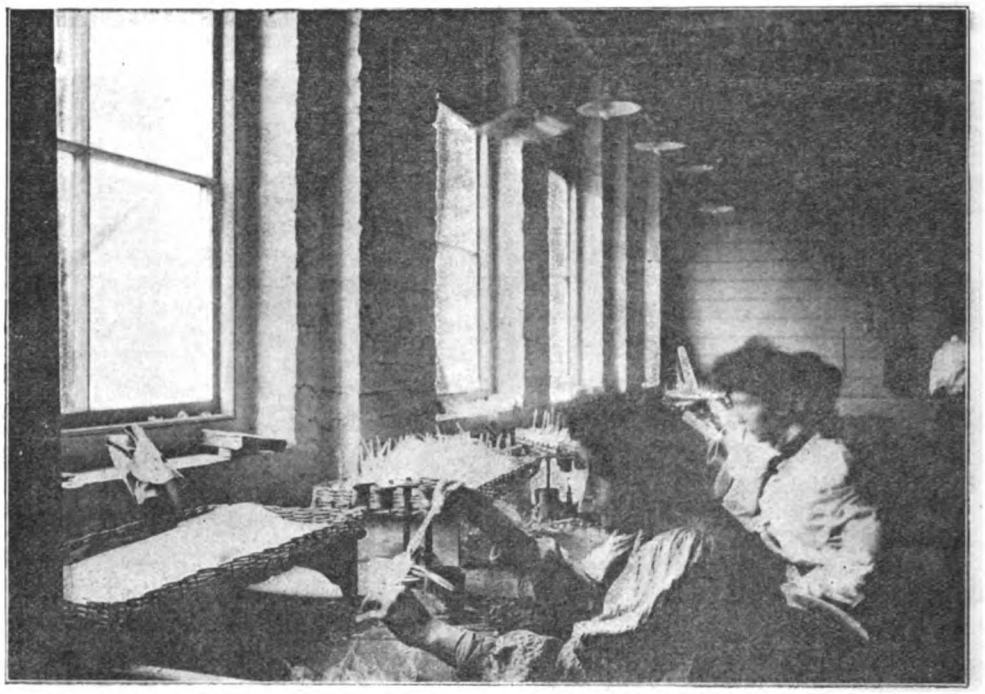

FIG. 5.—A Corner in the Glass-Blowing Room.

nators, storage batteries, air-pumps, and boilers. The air-pumps are used to give a fairly good vacuum before the

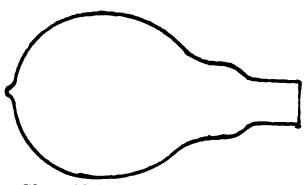

FIG. 4.—Glass Globe as it comes from the Mould.

mercury-pumps commence operation on the lamps. In an adjoining room are the retorts for carbonising the fila-

by pressure through orifices of suitable size. After other chemical treatment it is dried, and then wound

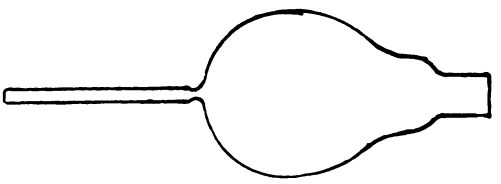

FIG. 6.—Globe with Exhausting Tube Attached.

on to carbon blocks which give it the desired form. It is then packed into crucibles and surrounded by plumbago

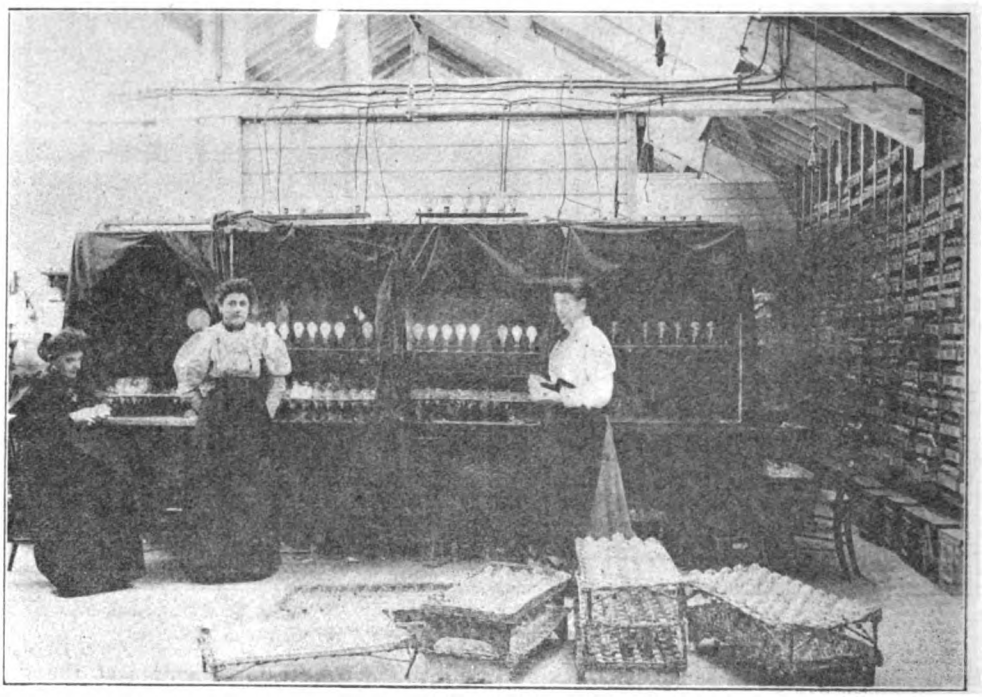

FIG. 9.—The Final Court of Enquiry at the Incandescent Electric Lamp Company's Works.

ments. The chemical operations in the manufacture of the carbon filaments are conducted on the ground floor. The carbon conductor in the lamps is in this case of

to prevent oxidation, the crucible and its contents being subjected to high temperature in order to carbonise the filament. The result is a carbon wire with a highly

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metallic lustre, so flexible and strong that it can be pulled out straight without fracture, even in its unflashed condition, as when taken out of the crucible. The material is so hard that it will scratch glass.

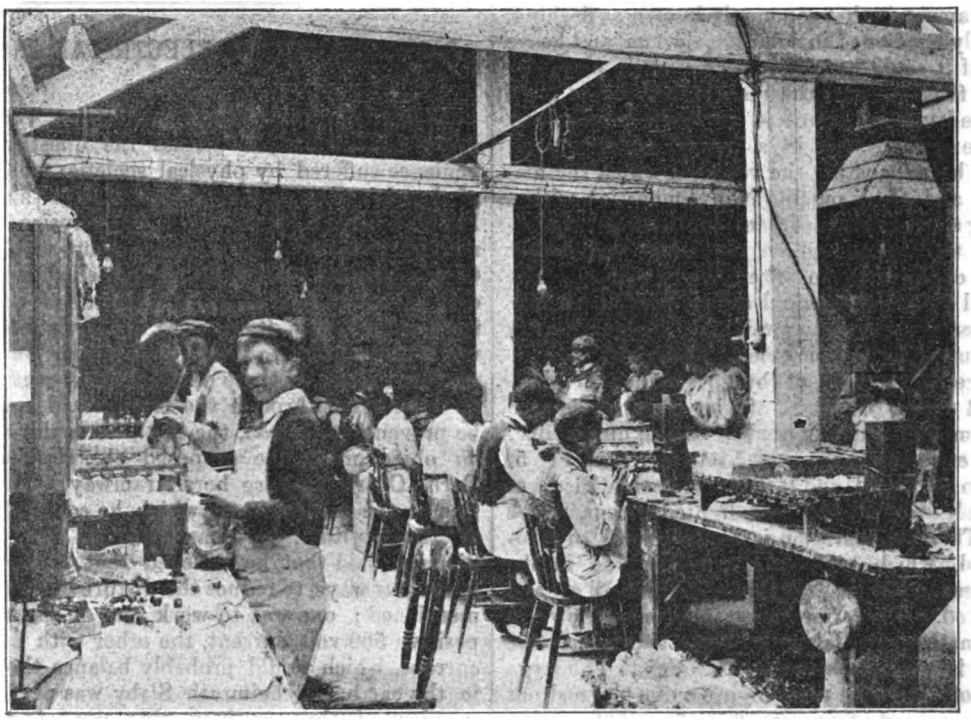

FIG. 10.—Capping Room.

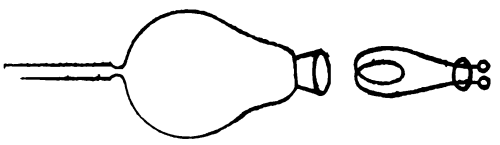

FIG. 7.—Globe Opened Out to Receive the Filament.

Moving up to the next floor, we come to the filament mounting department. A neat little machine, driven by a small motor, receives the platinum wire and cuts it up into the desired length. Two of these platinum wires are then mounted in glass at the correct distance apart. A small tube is formed at the inner end of each wire, into which the filament is slipped. A slight pressure with a pair of pliers fixes it temporarily, and the mounted filament is then taken to the table shown in Fig. 2. The

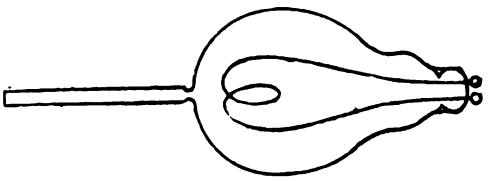

FIG. 8.—Lamp Ready to be Exhausted.

platinum loops are then connected up to a low-voltage supply, and the whole of the parts are immersed in some hydro-carbon solution. The filament is short-circuited by two clips, and the current passing them develops strong local heat at the junction of the carbon and

FIG. 11.—Cleaning and Ornamenting Room, showing Sand Blast in Further Corner.

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platinum, causing a good deposit of carbon at this place. Fig. 3 shows a view taken from another part of the same room, which gives a good idea of the excellent accommodation provided for the staff. The next operation on the carbon filament is that commonly known as flashing. This is necessarily conducted in a darkened room, and hence no photograph of it could be taken. The weak places in the filament are filled up, and the resistance of those to be used in the same type of lamps is rendered uniform by incandescing the carbon wire in a hydro-carbon vapour. This is obtained by exhausting the vessel in which the filament is placed and then putting it in connection with a bottle containing some mixture of benzine with other hydro-carbon liquids, the vapour given off being sufficiently rich in carbon compounds to effect the purpose. The various taps and switches required are so interlocked that there is no danger of an explosive mixture being formed in the globe and ignited by the incandesced filament.

The next stage is carried out by girls skilled in glass-blowing. Fig. 4 shows the shape of the glass globe as it comes from the mound which is used to ensure uniformity. These globes, after cleaning, are passed into the room, Fig. 5. This room is also darkened, and it was extremely difficult to take a photograph even of the best lighted corner, which we illustrate. The first operation is to fix a small tube on to the large end, which tube is afterwards used in the exhausting process as the passage through which all air and gases are extracted. The after-appearance is as shown in Fig. 6. Then another girl takes the globe and inserts the filament. This is most interesting to watch. The large tube is drawn off, and the remaining portion opened out to admit the mounted filament, Fig. 7. This being inserted, the hot glass is pressed back and united to that round the platinum wires. When finally sealed in, two indentations are made to give a good hold in the plaster when the capping operation is effected. After this the appearance is as in Fig. 8. The lamp then, after careful examination to ensure that the sealing-in process has been effectual, is passed into the exhausting room. The bulbs are sealed on to the exhausting tube of the pumps and a vacuum produced. During the process, which is commenced by mechanical pumps and finished by mercury-pumps of the Sprengel type, heat is applied to ensure that all volatile substances are evaporated both from the filament and the globe. A current is passed through the filament during the final stages, the lamp being considerable overrun. When the gauges show that exhaustion is complete, the lamps are sealed up and removed. The mercury-pump arrangements are exceedingly well designed, to ensure automatic raising of the mercury, and it is noteworthy that in no place is the mercury free to vaporise into the air of the room. Hence the operatives are not in danger of mercury poisoning.

The lamps now undergo most critical tests in the photometric rooms, etc. This department might well be associated with a court of justice, as only some 100 out of every 150 lamps succeed in establishing their right to circulate in society. The candle-power, voltage, and watts per candle are ascertained for each lamp, and most accurate subdivisions are gone into so that the necessary E.M.F.'s shall be given, even to half a volt. Then the lamps passing this test go into the hands of the three ladies shown in Fig 9. There the lamp is subjected to various processes, such as burning in series to prove uniformity of filament, of flashing with momentary current to discover weak places in the filaments, etc. Such lamps as do pass these exhaustive trials successfully are then capped in the room shown in Fig. 10. The mountings necessary to enable the lamps to fit the various makes of holders are attached by means of plaster. After the lamp passes through the drying-room, it is again carefully tested for contact, vacuum, etc, and the neatness and exactness of the capping ascertained. The etching of the word "Robertson," together with the candle-power and voltage, is carried out, and the lamps are cleaned and ornamented, if necessary, in the packing-room, shown in Fig. 11. The frosted globes are subjected to a sand blast, which can be seen in the further corner of the room. There is again a final test of the normal E.M.F. just before the lamp is packed and despatched.

The whole of the work is under the direction and supervision of Mr. C. J. Robertson, who devotes careful personal attention to the smallest details in manufacture.

DISTURBANCE OF ELECTRICAL INSTRUMENTS.

A meeting of the Elektrotechnischer Verein was held in Berlin on June 11, to discuss the question of the inconvenience suffered by physical societies from the proximity of electric railways, and the remedy for this inconvenience. Dr. Kohlrausch, president of the Physico-Technical Imperial Institute, referred to experiments which took place at Charlottenburg on May 27, and which showed that the delicate electrical measuring instruments of that institute suffered considerable disturbance, the deviation of the galvanometer amounting to 1'·12", and totally obviating accuracy of observation. If these derangements caused by the return of the current through the earth could not, as he feared, be prevented, he said, the institute could not help raising an objection to the proposed electrical working of the Berlin-Charlottenburg horse tramway. The highest deviation of the galvanometer which he could allow, as director of the institute, he remarked, was 6". Herr Wilh. v. Siemens said that he believed that it would be possible, in various ways, to reduce the disturbances to the maximum mentioned; one was to work one of the two tracks with positive 500-volt current, the other with negative 500-volt current, which would probably balance the return current in the earth. Geheimrath Slaby was of the opinion that, in view of the ever-increasing use of electric traction, physical societies must resign themselves to the inevitable, and learn, by improving their instruments, to combat the derangements; but Dr. Dubois energetically opposed this view, because the apparatus had already reached the limits of sensitiveness. Dr. Kohlrausch then read a passage from a letter of Werner von Siemens, referring to the institute, who warned electrical engineers, in their own interest, to give due regard to the claims of science. Prof. Dorn recommended, in conclusion, as avoiding the difficulty, the adoption of the double-trolley system of electric traction.

ELECTRIC LIGHTING ORDERS.

The following special reports by the Board of Trade under Section 1 of the Electric Lighting Act, 1888, have been issued:

(1) *Strand District Electric Lighting Order*, 1895.—The Charing Cross and Strand Electricity Supply Corporation, Limited, applied for a provisional order in respect of the district of the Strand Board of Works. The Board of Works, who are the local authority under the Electric Lighting Acts, on October 10 last passed the following resolution: "Resolved, that upon the terms stated in the report" (presumably the report of a committee of the Board to whom the matter has been referred) "the consent of the Board be given to the application of the Charing Cross and Strand Electricity Supply Corporation, Limited, for a provisional order to supply with electricity all the parishes forming the Strand district, and to their application to lay mains in the parish of St. Paul for the purpose of supplying electricity in the parish of St. Martin-in-the-Fields, and that as amended the report be adopted." And on April 10 last the following further resolution: "That subject to the alterations in the model form of provisional order provided for by the agreement" (an agreement proposed to be entered into by the Strand Board and the promoters of the order), "being sanctioned by the Board of Trade, the assent of the Board be given to the application of the Charing Cross and Strand Electricity Supply Corporation, Limited, to supply electricity within the Strand district." The alterations referred to in the latter resolution were accepted by the promoters, and some of them were adopted by the Board of Trade and incorporated in the order. Others consisted of detailed provisions as to the situation, construction, and size of the works incidental to the supply of electrical energy, which were to be constructed by the undertakers in the public streets and the hours during which the undertakers might have access to their street boxes. The Board of Trade thought it undesirable to specify in a provisional order, which can only be altered by a further provisional order, the precise details of construction in the case of works necessary to the supply of energy, and they were of opinion that the provisions already inserted in the order give the local authority ample power to control the construction of works in the public streets, and the hours during which the undertakers should have access to their street boxes. The remaining alterations were not, the Board of Trade understand, considered important by the Board of Works.

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The views of the Board of Trade were communicated to the local authority, who, as the Board of Trade are informed by the promoters, on May 22, passed a resolution rescinding the resolution of October 10, 1894, above referred to. A resolution was also proposed at the same meeting to rescind the resolution of April 10 set out above, but was not carried.

(2) *Windermere District Electric Lighting Order*, 1895.—The Windermere and District Electricity Supply Company, Limited, applied for a provisional order in respect of the districts or portions of the districts of the following local authorities—viz, the Windermere Urban District Council, the Ulverston Urban District Council, the Ulverston Rural District Council, the Bowness Urban District Council, the Grasmere Urban District Council, the Grange Urban District Council, the South Westmorland Rural District Council, the Ambleside Urban District Council, and the Corporation of Kendal. The promoters were unable to produce the consent of the last two local authorities, or to advance reasons sufficient to justify the Board of Trade in dispensing with such consent, and the Board of Trade omitted the districts of these local authorities from the area of supply under the order. The promoters on January 14 last entered into agreements with the Ulverston Urban District Council, the Ulverston Rural District Council, and the Grange Urban Council District with respect, amongst other things, to the purchase of the distributing mains and apparatus of the undertakers in these districts at the expiration of a period of 10 years from the commencement of the order, and in the case of the Ulverston Urban District Council the consent to the grant of the order was given, subject to the condition that the agreement should be incorporated in and form part of the order. The Ulverston Rural District Council and the Grange Urban District Council subsequently requested that the agreement might be specifically referred to in the purchase clause, and on the Board of Trade not being prepared to incorporate the agreement in the order a similar request was preferred by the Ulverston Urban District Council. The Board of Trade, while willing to give the local authorities powers, with the consent of the Board, to purchase the distributing mains, etc, considered that it was not expedient to refer to the agreement in the order. They communicated with the three local authorities concerned, one of whom—the Grange Urban District Council—still wished to have a reference to the agreement in the order; whilst the other two—the Ulverston Urban and Rural District Councils—asked that words should be added to the purchase clause to provide that any agreement already entered into shall be subject to such alterations as the Board of Trade, on consent being applied for, determine to be just and reasonable. The promoters, however, declined to accept the proposed addition, and the Board of Trade did not, therefore, feel justified in inserting it.

(3) *Liverpool Electric Lighting Order*, 1895.—In 1891 and 1892, the Liverpool Electric Supply Company, Limited, obtained provisional orders authorising the supply of electrical energy within a portion of the city of Liverpool; and, in the former year, they also obtained an order authorising the supply of energy within the adjoining district of Toxteth Park. The provisions of the orders relating to the two districts varied considerably. In December last the company applied for a provisional order, which proposed to repeal the existing orders and to re-enact the provisions of the Liverpool orders, with some modifications, making them applicable to the district of Toxteth Park, as well as to the portion of Liverpool. The Corporation of Liverpool have applied to the Local Government Board for a provisional order authorising the extension of the boundaries of the city so as to include the urban district of Toxteth Park, and the application is now under the consideration of that Board. The Urban District Council did not consent to the grant of the electric lighting order, but the Corporation of Liverpool (who will, if the Local Government Board order be confirmed, become the local authority for the Toxteth Park district in place of the Urban District Council) consented to the electric lighting order, and desired that it should be granted in the form in which it is scheduled to the confirming Bill. The Board of Trade, therefore, decided to grant the electric lighting order, with a proviso that it shall not have any force or effect unless the boundaries of the city of Liverpool are by a provisional order made by the Local Government Board, and confirmed by Parliament during the present session, extended so as to include the urban district of Toxteth Park. If the order of the Local Government Board is not confirmed this session, the electric lighting orders of 1891 and 1892 will remain in force.

LEGAL INTELLIGENCE.

THE SOUTHWARK BRIDGE EXPLOSIONS.

Before Judge Emden, sitting at Lambeth, on Tuesday, a case described by his Honour as one of considerable importance to the public, was tried, arising out of the explosions that occurred on February 1 last on Southwark Bridge. The plaintiff, James Price, was crossing the bridge about noon on the day mentioned when four explosions took place at different points on Southwark Bridge, the pavement being blown into the air, together with several persons, who sustained various injuries.

Mr. Lynden Bell, who appeared as counsel for the plaintiff, said this was a test case, and the claims of other persons depended upon its result. He called Major Cardew, R.E., an inspector of the Board of Trade, who had held an enquiry on February 4. He attributed the explosions to an accumulation of gas in the mains.

Mr. Hicklin, for the defendants, the South Metropolitan Gas Company, called **Mr. Livesey**, and other witnesses, who attributed the fracture to the excessive frost, which had hardened and expanded the earth above the pipe and increased the pressure upon it. They also alleged that the earth under the pipe had been moved by other parties who were laying adjoining pipes, and that the support of their pipe was thereby reduced.

His **Honour** considered that negligence had been established—first, in that the defendants had not discovered the fracture by the smell of the escaped gas, and also in not seeing that their pipes were left properly supported after other persons, to their knowledge, had been excavating and working around them. He gave judgment for the plaintiff—£12 damages, and costs on the higher scale, but with leave to appeal.

ALLEGED SMOKE NUISANCE.

Mr. Wm. R. Renshaw, as the responsible head of the Queen Anne's-mansions Lighting and Heating Works, St. James's Park, was summoned on Wednesday at the Westminster Police Court by the Westminster Vestry for permitting the issue of dense black smoke from a chimney, so as to be a nuisance.

Mr. Arthur Kent prosecuted for the Vestry, and stated that a furnace was employed to generate electricity, etc., for the whole of the mansions. In respect of the same sort of nuisance in July, 1893, a fine of £5 was imposed.

The **Defendant's Manager**, in extenuation, put it that the smoke from their own large chimney was no more than the aggregate from smaller chimneys of houses accommodating even fewer families than the mansions provided accommodation for.

Mr. De Rutzen: In other words, your defence is that the mansions are entitled to their volume of smoke proportionately to their inhabitants. It is the biggest and most unsightly block of buildings in London, but that it has a right to poison the surrounding locality is an argument that has no weight with me. There must be a fine of £5 and £5. 5s. costs.

COMPANIES' MEETINGS AND REPORTS.

INDIAN AND GENERAL INVESTMENT TRUST, LIMITED.

The seventh ordinary general meeting of this Company was held on Tuesday at Winchester House, Sir H. Seymour King, K C I.E, M.P., presiding.

The **Chairman**, in the course of his speech moving the adoption of the report and accounts, said: "I refer now to the loss made on an advance on Woodhouse and Rawson debentures. We made that advance—and I am bound to say we should make it again, given the circumstances—on debentures which had £480,000 of capital behind them. We advanced about 80 per cent. of those debentures, which were given in part purchase for property, therefore apparently adding safety and security to the debentures themselves Subsequently, out of an issue of about £185,000 of those debentures, £120,000 were converted into a 5½ per cent. debenture, ranking behind those who did not convert. Your directors thought it wiser to stay in front, and did not convert, and therefore we stood ultimately in the position of holding £12,000 of debentures out of £65,000 of a first mortgage charge, with £120,000 second charge behind us and £481,000 of share capital—in other words, £600,000 of money—so far as the accounts go, which were put forward by responsible men—as security, we thought, for our debentures. By an operation which I prefer not to characterise, £20,000 was put ahead of us by withdrawing certain securities over which we had only a floating charge, and giving a specific lien. I have my own opinions about transactions of that nature, and I think they are shared by most people who desire to support straightforward finance. At any rate, £20 000 was put ahead of us, and the result of the winding up and liquidation of that company has proved to be that the first debentures of all get 17s. in the pound, we get about 6s., and nobody else gets a halfpenny. In other words, about £30,000 now represents £685,000—the money that was subscribed in the City of London. I think, gentlemen, we may ask you to commiserate with us, and not to blame us, under the circumstances, for having made that loss. I attended a meeting the other day which was convened to consider whether we should sue the directors and try and get back some of this money. I would have voted gladly for any punishment that could have been inflicted upon them, but, after very careful consideration, I came to the conclusion that it would be throwing good money after bad, that although we might have a judgment, I was not at all sure that we should get more than the paper upon which it was written. So I thought we had better throw in our lot, take what we had got, and cut the loss."

ELECTRIC AND GENERAL INVESTMENT COMPANY, LIMITED.

Directors: George Herring, chairman; the Right Hon. Lord Cloncurry; J. B. Braithwaite, jun.; B. H. Van Tromp; Emile Garcke, managing director.

Report of the directors to be submitted to the sixth ordinary general meeting of the shareholders to be held at Winchester House, Old Broad-street, E.C. (hall No. 47), on Tuesday, July 2, 1895, at 3 p.m.

The directors beg to submit the balance-sheet and profit and

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loss account for the year ended May 31, 1895. The profit and loss account shows a gross profit on the transactions of the year of £8,470. 17s. 1d., and after deducting all standing charges and the interim dividend already paid on the ordinary shares, there remains a net balance available for distribution of £5,330. 13s. The directors now recommend the payment out of the profits for the past year of a further dividend upon the capital paid up on the ordinary shares at the rate of 30 per cent. per annum for the past six months, and a dividend on the founders' shares of £20 per share for the year. This will leave a balance of £330. 13s., which the directors recommend should be added in equal moieties to the reserve funds of the holders of the ordinary and founders' shares. The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £15. 16s. per share out of the proceeds of investments sold and dividends received, making, with the before-mentioned dividend, a total distribution of £35. 16s. on each founder's share. The directors who retire this year are Lord Cloncurry and Mr. Braithwaite. The latter offers himself for re-election, but Lord Cloncurry permanently retires, on account of his continued residence in Ireland. The auditors, Messrs. Rait and Kearton, having dissolved partnership during the year, Mr. Rait was appointed by the Board to audit the accounts. He now retires, but offers himself for re election. It is proposed to make the dividends payable on July 3, 1895.

BALANCE-SHEET AT MAY 31, 1895.

Capital authorised—£200,000 in 39,900 ordinary shares of £5 each and 100 founders' shares of £5 each.			
Capital subscribed—20,000 ordinary shares and 100 founders' shares.			
Capital called up—			
£1 per share on 20,000 ordinary	20,000	0	9
£5 per share on 100 founders'	500	0	0
	20,500	0	0
Reserve fund—founders' shares—amount invested as *per contra* £9,274 0 3			
Ditto—dividends received and investments sold by trustees 1,584 2 8			
	10,858	2	11
Reserve fund—ordinary shares	10,318	0	7
Provision for contingencies	8,000	0	0
Loan account	26,790	0	0
Sundry creditors	1,431	2	8
Balance of profit and loss account	5,330	13	0
	£83,227	19	2

Note —There is a liability amounting to £8,516. 5s. in respect of calls that will become due on securities held by the Company.

Investments at cost	£69,821	8	2
Sundry debtors	1,924	15	5
Cash in hand and on current account at bankers	2,207	15	4
Founders' reserve fund, amount invested, at cost	9,274	0	3
	£83,227	19	2

PROFIT AND LOSS ACCOUNT, YEAR ENDED MAY 31, 1895.

	£	s.	d.
General charges, including directors' fees, and additional remuneration as per articles of association, general expenses, legal charges, advertising, printing, and auditor's fee, etc.	2,140	4	1
Interim dividend paid December 20, 1894, at the rate of 10 per cent. per annum for six months	1 000	0	0
Net profit available for division	5,330	13	0
	£8,470	17	1
	£	s.	d.
Interest, dividends, commissions, and sundry profits	8,470	17	1
	£8,470	17	1

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bucharest.—The Roumanian Ministry of Public Works invite tenders by June 29 for the concession of the building and working of a line of tramway in Bucharest. Preliminary security, 10,000f.

Medina del Campo.—The municipal authorities of Medina del Campo, Valladolid, Spain, invite tenders by June 27 next for the electric lighting of the town for a period of 20 years. Security, 5,000 pesetas.

Clevedon (Somerset).—Tenders are invited for the public lighting of their district every night in the year from sunset till midnight, for the Urban District Council. Tenders to be for one, two, or three years, and to be sent to Mr. Hy. C. Fry, clerk, Clevedon, by July 1.

Braila.—Tenders are invited by the municipal authorities of Braila, Roumania, by June 17 (29), for lighting the town by gas and electricity. Security required, 25,000f.—Tenders are also invited by June 17 (29) for the construction and working of electric tramways in Braila. Provisional security, 10,000f.

Harrow.—Tenders are invited by the Harrow Urban District Council for lighting their district. The specification may be seen and every information obtained on application to Mr. T. Charles, surveyor, High-street, Harrow. Tenders, endorsed "Tender for Public Lighting," to be sent to Mr. R. E. H. Fisher, clerk, Harrow, by 27th inst.

Motherwell (Scotland).—Tenders are invited by the District Committee of the Lanark County Council for the electric lighting of the new hospital being erected near Motherwell. Copy specifications and plans may be seen at the office of Mr. Alexander Cullen, architect, Motherwell. Sealed tenders, marked "Tender for Electric Light," to be lodged with Mr. J. F. Mackenzie, district clerk, County Buildings, Hamilton, by July 1.

Blackburn.—The Corporation of Blackburn invite tenders for the wiring of the town hall. Copies of the specification may be obtained from the engineer, Mr. E. M. Lacey, of 19, Old Queen-street, S.W., on payment of £1. 1s., which will be refunded on return of same accompanied by a bona fide tender. Plans may be seen at the office of the town clerk, or the engineer, from whom any further information can be obtained. Tenders must be sent in by July 13.

Preston. — Tenders are invited for the wiring and fittings required for the lighting by electricity of the Town Hall and public hall buildings. Specifications and conditions at the borough engineer's office, Town Hall, Preston, on payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Separate sealed tenders for each of the buildings must be sent to Mr. Henry Hamer, town clerk, Town Hall, Preston, endorsed "Tenders for Electric Lighting," by 12 noon on July 1.

Inverness.—Tenders are invited for the following articles, among others, from July 1, 1895, to June 30, 1896, delivered free of all charges, viâ Dunkeld, at the company's storehouses, Inverness, for the Highland Railway Company: telegraph instruments and fittings and telegraph construction material. Forms of tender may be had on application to Mr. J. G. Bulmer, storekeeper, Inverness. Tenders, properly endorsed, sealed, and addressed to the directors, must be lodged with Mr. And Dougall, secretary, Inverness, by to-morrow.

Bedford.—The Electric Light Committee are prepared to receive tenders for the supply and erection of the following plant: Section A—Two water-tube boilers; Section B—two 140-b.h.p. double-acting compound enclosed engines; Section C—two 90-unit alternators with stationary armature. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. T. G. Porter, clerk to the Urban Sanitary Authority, on payment of a fee of 7s. 6d. for each section. Tenders, sealed, and marked "Electric Lighting, Section A, B, or C," are to be delivered by Tuesday, 25th inst.

Bradford.—Tenders are invited for the supply of best gas coal, cobbles, nuts, and cannel, all to be well screened, dressed, and free from shale and pyrites, to be delivered at the several works of the Corporation in the borough during one year or two years, commencing August 1, for the Gas and Electricity Supply Committee. Form of tender, with any further information required, may be had on application to Mr. Wood, gas engineer, Town Hall. Sealed tenders, endorsed "Tender for Coal," to be sent to Mr. W. T. McGowen, town clerk, Town Hall, Bradford, by July 3. An assurance must be given by each contractor that he pays to the workmen employed by him not less than the minimum standard rate of wages.

Birkenhead.—Tenders are invited by the Corporation for the erection and completion of the engine and boiler house and other buildings, walls, etc. (the chimney excepted), in connection with the proposed electrical generating station at Bentinck-street, Birkenhead. Plans, specifications, and particulars, with the form of contract, can be seen, and (upon deposit of £2. 2s., which will be repaid upon receipt by the Corporation of a bona fide tender) bills of quantities, with form of tender, can be obtained on application at the Town Clerk's Office, Town Hall, Birkenhead, or at the office of Mr. James N. Shoolbred, M.I C.E., Albany-buildings, 47, Victoria-street, London, S.W. Tenders, which must be on the prescribed form, sealed and endorsed "Tender for Electrical Generating Station," must reach Mr. Alfred Gill, town clerk, Town Hall, Birkenhead, by noon on 27th inst.

Madrid.—The Spanish Postal and Telegraphic Administration invites tenders by June 28 for the supply of 20 tons of copper. Preliminary security 5 per cent., definitive security 10 per cent., maximum price 520 pesetas per ton. Conditions, etc., and forms of tender from La Direccion General de Correos y Telégrafos, Madrid.—The Spanish Postal and Telegraphic Administration invites tenders by June 29 for the supply of 40,000 white and 10,000 grey porcelain insulators. Maximum price, 1 peseta 5 centesimos for the white and 1 peseta 10 centesimos for the grey. Provisional security, 2,650 pesetas; definitive, 10 per cent. of the estimate. Tenders are also invited by June 30 for the supply of 25,000 zinc cylinders for Calland elements. Maximum price, 980 pesetas per 1,000; provisional security, 1,225 pesetas; definitive, 10 per cent. of the estimate. Conditions and forms of tender from La Direccion General de Correos y Telégrafos, Madrid.

St. Helens.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of the following plant: Section A—boiler-house plant, including boilers and fittings, forced-draught apparatus, feed pumps, etc.; Section B—engine-house plant, including steam alternators, oil-filter, fittings, etc., steam, exhaust, feed, blow-off, and sundry pipes, valves, and water-tanks, etc.; Section C—main switch-board and instruments; Section D—underground work, including cables, junction-boxes, culverts, and trenching; Section E—trans-

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formers and fittings; Section F—meters; Section G—overhead crane. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. The ground plan of plant, plan of streets, etc., and specification, with terms and conditions of tender and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on and after June 11, on payment of £2 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed, and marked "Tender for Electric Lighting," must be addressed to the town clerk at the Town Hall, St. Helens, and be delivered on or before Tuesday, July 2.

RESULTS OF TENDERS.

Worcester.—The tender of Messrs. Graham and Biddle, London, for wiring the Victoria Institute has been accepted by the Corporation. The amount is £768.

Burton-on-Trent.—The Town Council have accepted the tender of the Telegraph Manufacturing Company, Helsby, for supply of the iron piping for the high and low pressure cables for the extension of the electric light system across the Burton Bridge and along Ashby and Alexandra roads.

Hanley.—The Town Council have accepted the following tenders: E. Danks, Oldbury, two boilers and appurtenances for the electric lighting works, £1,178; W. R. Renshaw and Co., Cliffe Vale Works, Stoke, water-tank, etc., £164. 18s.; and S. Z. de Ferranti, switchboard, etc., £252. 10s.

Brighton.—The Corporation have received the following tenders for the supply and delivery at Brighton of 80 cast-iron and drawn-steel bracket posts for suspending electric light arc lamps:

Pierson and Co., 124, Fenchurch-street, London	£3,680
Newton, Chambers, and Co., Limited, Sheffield	2,640
Hart, Son, Peard and Co., Limited, Birmingham (accepted)	2,600

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,389.

Transvaal.—At the New Comet mine the electric lighting installation is now in working order.

Ipswich.—The Town Council have postponed the question of applying for a provisional electric lighting order.

Stettin Electricity Works.—The Stettiner Elektricitätswerke pay a dividend of 6 per cent. for 1894, against 5½ per cent. in 1893.

Beckenham.—The Urban District Council have received a letter from the Crystal Palace District Electric Supply Company notifying a reduction of the company's charges for the supply of electricity.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 16th inst. amounted to £1,268, as compared with £882 in the corresponding week of last year, being an increase of £386.

County of London and Brush Provincial Electric Lighting Company, Limited.—An instalment of £2 per share becomes due on 29th inst. on the first issue of 10,000 6 per cent. cumulative preference £10 shares.

Fleetwood.—The District Council have held a meeting at which it was resolved that the correspondence from the Brush Electrical Engineering Company, Limited, with reference to the question of electric lighting in the district, be referred to the clerk for reply.

Ayr.—Mr. Hammond, the consulting engineer in connection with the electric light station, at a meeting of the Town Council reported that the current would be available on September 1. The cost of the extension of the cables outside the compulsory area was £990. 12s. 4d.

Madras Electric Tramways Company.—On the petition of the Commercial and Land Mortgage Bank for the winding up of this Company, counsel stated that the debt had been paid, and asked for leave to withdraw the petition. Mr. Justice Romer sanctioned the withdrawal.

W. T. Henley's Telegraph Works Company, Limited.—At an ordinary general meeting of this Company, held on Friday last, an interim dividend of 6s. per share, free of income tax, was declared on the ordinary shares of this Company, payable on August 1, 1895.

Walthamstow.—The Examiners of Standing Orders of the House of Lords have reported that the Provisional Order Bill for enabling the Walthamstow District Council to undertake the lighting of the district by electricity is in compliance with the standing orders.

Indo-European Telegraph Company, Limited.—This Company is prepared to receive, at its chief office, 18, Old Broad-street, on and after July 1 next, applications for the sixth series of coupons to be issued to holders of share warrants to bearer in this country. The application must be made on the printed forms provided for the purpose.

Christchurch.—A meeting of the Town Council has been held, at which the clerk reported that a scheme for lighting the town by electricity had been brought before the Roads Committee. Alderman Lane proposed that the Council should consider the question in committee, and that Mr. Burt be requested to attend the meeting.

City and South London Railway.—The returns for the week ended June 16 were £862, compared with £831 for the corresponding period of 1894, being an increase of £31. The total receipts for the current period of the present half-year are £22,299 against £21,755 in the corresponding period of 1894, an increase of £544.

Lambeth.—The Vestry at their last meeting resumed the consideration of the letter from Mr. Sidney Morse, offering, on behalf of the County of London Brush Provincial Electric Lighting Company, to take over, conditionally, the Vestry's provisional electric lighting order. After some discussion, it was decided to refer the matter to the Lighting Committee.

Heilmann System.—The Société Industrielle des Moteurs Electriques et à Vapeur, which exploits the Heilmann electric railway system, and has received an order from the French Western Railway Company for two electric locomotives, has been reconstructed. The old style of the company is retained, and the capital has been fixed at 4,000,000f., or £160,000.

Buxton.—A meeting of the Urban District Council has been held, at which it was reported that the Council in committee had received a letter from Messrs. Parsons and Co. It was resolved that the clerk write for information on the question of the transfer of electric lighting powers to the town clerks of Scarborough, Cambridge, and Newcastle.

Edinburgh.—The Lord Provost's Committee of the Edinburgh Town Council have agreed to recommend the Council's approval of the Electric Light Committee's report, which proposes to extend the high-tension mains to the Royal, Regent, and Carlton terraces, to the south back of Canongate, George-square, and the south side of the city, at a probable cost of £5,000.

Crompton and Co., Limited.—In Chancery, Mr. Justice Romer has sanctioned a petition for the reduction of the capital of this Company by a sum of £20,000, the reduction to be effected by the cancellation of 4,000 ordinary fully paid-up shares, that amount having been lost, or being unrepresented by available assets. Counsel said that the original capital of the Company was £300,000.

St. Pancras.—The Finance Committee of the London County Council on Tuesday reported that the St. Pancras Vestry loan of £14,300 for electric lighting purposes had been completed, and that the solicitor had been directed to hand the mortgage deeds to the Corporate Property Committee. The Vestry have decided to postpone the election of a chief electrical engineer for a fortnight. The candidates are Messrs. S. W. Baynes, B. Deakin, and H. R. J. Burstall.

Cramp Manganese Bronze Company of Great Britain, Limited.—This Company has been registered, with a capital of £50,000, to adopt and carry into effect an agreement, the parties to which are not named, and to carry on the business of manufacturers and workers of and dealers in bronze and other metals, or metallic alloys; also as metallurgists, miners and smelters, civil, electrical, marine, and mechanical engineers, etc., in all or any of their respective branches.

Coventry.—A local paper states that it will become necessary to dismantle a very large engine at the electric lighting works, owing to defects having been discovered in the foundations of the stonework on which the machinery stands. The matter is a somewhat serious one, because of the importance of an engine of the size of that fixed there resting on a secure bottom, but it is only fair to state that the building contractor is not held responsible for the defects which necessitate a portion of the work being done over again.

Whitehaven.—At a meeting of the Whitehaven Rural District Council the Water and Lighting Committee reported that the engineer has submitted plans of the proposed extension of the electric light station, and it was resolved to leave the matter in the hands of a sub-committee. The engineer reported that the two new engines and dynamos at the central station were completed on 27th ult. and were working. New mains for private lighting have been laid in Lower Queen's-street, Coates-lane, and Roper-street.

Change of Address.—The County of London and Brush Provincial Electric Lighting Company, Limited, inform us that they removed to Moorgate-court, Moorgate-place, London, E.C. Messrs. Clayton and Shuttleworth inform us that, on and after June 24, their London office and showrooms will be at 95, Queen Victoria-street, where they will exhibit motors for thrashing, electric lighting, sawing, pumping, and general purposes, comprising portable and fixed steam-engines, patent oil and gas engines (in motion), and other articles.

Manchester.—A meeting of the Town Council has been held, at which Mr. Alderman Higginbottom moved the adoption of the proceedings of the Gas Committee. He said that the tender of Mr. B. Goodfellow for eight pairs of compound condensing engines for the sum of £12,440, the tender of the Electric Lighting Construction Company for eight dynamo-electric machines for the sum of £7,381, and of Messrs. Heaton and Son for five Lancashire boilers for the sum of £5,371 had been accepted, in accordance, in each case, with the resolution of the Council.

Appointment Vacant.—The Streets Committee of the City Commissioners are about to appoint a working mechanic at a weekly wage of 30s. for their electrical laboratory. Applications, stating age, details of training, and experience, must be addressed to Mr. H. Montague Bates, principal clerk, Guildhall, and delivered, together with copies of not more than three recent testimonials, by 12 noon on July 2. Applicants must have had experience in electrical work, and specially in the handling, fixing, and adjusting of

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meters. Preference will be given to candidates with a knowledge of the work of an electrical testing-room.

Dewsbury.—A meeting of the Town Council has been held, at which Alderman Robinson, in moving the confirmation of the minutes of the Lighting and Water Committee, said the Council would no doubt be pleased to notice that, notwithstanding the fact that the electrical energy sold was 846 units for the two weeks ending May 11, the quantity of gas distributed was in excess by 90,000 cubic feet for the same period last year, and that the quantity for the succeeding fortnight was nearly 500 000 cubic feet more than for the corresponding period of last year.

Liverpool.—The Midland Railway Company have erected a very large warehouse at the Sandon Dock. The warehouse and yard, including the adjoining cotton quay and offices, are illuminated by the electric light, the plant for which comprises three horizontal two cylinder engines by Messrs. Davey, Paxman and Co, Colchester. Two of these have cylinders 12in. and 14in. stroke and 28ft. flywheels, each driving a Thomson-Houston 50 arc light dynamo, and there is one smaller engine with cylinders 9½in and 12in. stroke, driving a 30 unit Edi-Hopkinson dynamos for office lighting, etc.

Tramway Fares.—Evidence of the desire of the Board of Trade to co-operate with Mr. A. C. Morton in his endeavour to prevent the raising of tram fares on Sundays and public holidays is contained in two Provisional Order Bills now before the House of Lords. The orders confirmed by these measures relate to the Somerton, Keinton-Mandeville, and Castle Cary Tramways, the Hartlepools Tramways, the Hartlepools Electric Tramways, the Newcastle upon-Tyne Corporation Tramways, the Wigan and District Tramways, the Gloucester Tramways, and the London United Tramways; and in every case a clause has been inserted prohibiting the practice against which the member for Peterborough protests.

Islington.—The vestry clerk at a meeting of the Vestry read a communication from the Board of Trade, giving a provisional approval to the system of electric lighting adopted by the Vestry. He stated that he had received a copy of the regulations which the Board of Trade proposed to issue for the protection of the public. One clause was highly objectionable It was to the effect that all conduits and receptacles should be so constructed as to prevent an influx of gas from the adjacent soil. If that were passed, the Vestry would be at the mercy of gas companies, instead of requiring gas companies to prevent the escape of gas from their mains into electric lighting conduits. On the motion of Mr. Chamberlayne, the regulations were referred to the Electric Lighting Committee, with power to act.

Dispute at the Edison and Swan Works.—Under the auspices of the Electrical Trades Union a meeting of trade unionists was held at Ponders End on Saturday in support of the men, women, and boys on strike at the Ponders End Works of the Edison and Swan United Electric Light Company. Mr. G. W. Montague (president of the Electrical Trades Union) occupied the chair, and said they had to thank Sir Charles Dilke for calling the attention of the Government to the fact that the firm, although engaged on Government work, was not paying the trade union prices, contrary to the conditions of the contract. He believed the matter would be taken up in the House of Commons, and by that means the duration of the strike would be materially lessened. He expected the strike would last only a few days longer.

Harrogate.—A meeting of the Town Council has been held, at which the General Purposes Committee stated that the Electric Lighting Sub-Committee reported, as to electric lighting plant, that the borough surveyor laid before them an account as to what had been done as to buildings and plant preparatory to carrying out the electric lighting order. The town clerk reported that, as instructed by the sub-committee, he had invited Mr. Robert Hammond, consulting engineer, to meet them and Mr. Wilkinson, the electrical engineer, with a view, before carrying out the scheme which had been adopted by the Council, of having the whole reconsidered as to the system, the site, and the area of supply. Mr. Hammond attended the committee, and undertook to examine what had been done, and to report upon the whole scheme, and the Mayor, the chairman of the committee, and Alderman Ward, were appointed as a sub-committee to confer with him thereon. It was resolved that the report be approved and adopted. Mr. Hammond has promised to report as soon as he possibly can.

Telephones for the Fire Brigade.—The Fire Brigade Committee of the London County Council, on Tuesday, reported that the Council recently sanctioned the establishment of telephonic communication between the Watling-street station and five places in the City where firemen are on duty by day as well as by night. The chief officer now asks that similar communication may be established between the Bishopsgate station and the watch boxes in Eastcheap and Finsbury-circus, at which firemen are also on duty by day and night, and that the fire alarms near such boxes may be dispensed with. The Post Office is prepared to maintain these lines of communication for £16 a year. As, however, annual charges amounting to £15 for the fire alarms will shortly cease the increased annual cost will be only £1. The committee recommended that telephonic communication should be established between the Bishopsgate fire-engine station and the fire-escape and hose-cart stations in Eastcheap and Finsbury-circus, the existing fire alarms near such street stations to be dispensed with.

Twickenham.—A meeting of the District Council has been held, at which the clerk read the report of Mr. Collin Brodie, the expert who was commissioned by the Council to report on the instruments offered for the working of the fire calls by Messrs. Harrison and Coles, and Mr. Stuart. In this, Mr. Brodie stated that in his opinion Messrs. Harrison's magneto-apparatus was not suitable for the purpose for which it was intended, and that, on the whole, Mr. Stuart's tender was the best, and should be accepted. Mr. Webb asked if Mr. Brodie had had all the correspondence? The Clerk: Everything. Mr. Messom said that after hearing that report he should move that Mr. Stuart's tender be accepted subject to the amendments suggested in the report. Mr. Beard seconded, who said they could not act otherwise after having the experience of the expert. Mr. Buller asked if the property owners could object to having a line of telegraph posts in their neighbourhood. Mr Laffan said he had no doubt that they could get the wayleaves, and then posts would not be necessary. The motion was carried.

Derby.—The Markets Committee of the Town Council on Thursday last week inspected the electric lighting of the Derby Market Hall. Mr. Butterworth (deputy-chairman), accompanied by a representative committee and the borough surveyor (Mr. R J. Harrison) met the contractors, Messrs. John Davis and Son, of All Saints' Works, at 9 p.m., when the electric light was switched on. The arc lamps in the interior of the hall number six, taking 20 amperes each. The approaches are also lighted by arc lamps. Each stall and shop is provided with its own incandescent lamps. There are approximately 400 incandescent lamps throughout the buildings. The committee much appreciated the general lighting arrangements, and were exceedingly interested in the elaborate switchboard which controls the various circuits, six in number. The arrangement has been very carefully thought out. Each group of lamps is provided with a safety cut-out on each main. Each section of lighting is again provided with a safety cut-out which is again repeated on the main switchboard, so that should any short-circuit occur in any individual lamp only a very small section of lighting is temporarily extinguished. The meters are so arranged that the current being consumed by any of the various sections may be ascertained at a glance.

Leeds.—The Yorkshire House-to-House Electricity Company, Limited, are about to further reduce their price for electricity. The new scale of charges comes into operation on July 1, when the maximum gross price will be 6d. per unit. This is reduced to 5¾d. per unit in the case of consumers of not less than 1,500 units per quarter, and to 5½d. per unit when the consumption for the quarter exceeds 3,000 units. A scale of discounts is also announced, the benefits of which are available equally to the smallest and largest consumers, the discounts being calculated upon the consumption per lamp. A consumer using his lamps not less than 300 hours in the quarter is entitled to a discount of 5 per cent., and for a greater number of hours' use the discount increases up to a maximum of 15 per cent. An additional discount of 5 per cent. is allowed in all cases for prompt payment. Under the new scale the minimum net price is slightly under 4½d. per unit, whilst the greatest price payable by any consumer is just under 5¾d. per unit. Leeds will thus have the benefit of one of the cheapest supplies of electric light in the country. For heating, cooking, and motive power the company are supplying current at 3d. per unit. The use of electricity for these purposes is steadily extending. The number of lamps now connected to the mains is about 28,000, compared with 11,500 a year ago.

The Epping Forest Railway.—On the 13th inst. the London, Walthamstow, and Epping Forest Railway Bill came before a Select Committee of the House of Commons, presided over by Sir C. Dalrymple. Mr. Arnold Statham, who represented the promoters, stated that the object of the Bill was to improve the engineering clauses of the Act of last year, which was passed in order to relieve the congested areas north and east of Liverpool-street, and to enable the workmen of that large industrial area to reach Epping Forest to escape from the vitiated atmosphere in which they worked during the day, and to obtain cheaper dwellings than they could get in and about London. The financial prospects of the scheme had improved since last year, inasmuch as satisfactory arrangements had been made with the Midland Railway Company, by which they would carry passengers over the new line, and the present Bill was required for the formation of junctions with the Tottenham and Forest Gate and the Tottenham and Hampstead lines. All the petitioners against the Bill had been satisfied, including the County Council on the question of workmen's trains and fares, and, as a result, the alternative Bill for the abandonment of the line would be withdrawn. Mr. W. Beswick Myers, one of the engineers, gave evidence in support of the Bill, and the committee declared the preamble proved.

Pembroke (Ireland).—Mr. Clifton Robinson, managing director of the Dublin Southern District Tramway Company, and Mr. Little have waited on the Pembroke Township Commissioners to discuss certain minor differences between the Commissioners and the company as to the building of the electric tramway. Mr. Robinson said the work on the tramway in the whole Blackrock section was now within measurable distance of completion. They had been assured by the contractors that the road could be ready and open for inspection on July 3 next. The directors desired him to assure the Commissioners that they were perfectly ready and anxious to carry out the work in conformity with their order and their Act, and to meet the requirements of the Board in every way. With regard to the present state of Northumberland-road, they had opened it before they should in order to convenience the people connected with the show, and consequently it was not in the condition it should be. Of course, until the company put the road in perfect condition, the Board of Trade inspector would not pass it for public traffic. The company hoped to be able to give them a street railway which would be second to

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none in its progressive character. Nothing in the world had ever been built of the kind which had cost so much money as this line. After the deputation had withdrawn the clerk was given directions to act in the matter as the Board's solicitor might advise.

Liverpool Electric Supply Company. — An extraordinary general meeting of the Liverpool Electric Supply Company, Limited, is to be held on the 22nd inst. for the purpose of considering and (if thought fit) passing the undermentioned resolutions: "(1) That the agreement now submitted to the meeting, dated May 28, 1895, entered into between the Company of the one part and the mayor, aldermen, and citizens of the city of Liverpool (hereinafter called the Corporation) of the other part for the sale of the undertaking of the Company to the Corporation be approved, subject to such alterations as Parliament may see fit to make therein. (2) That the Company do apply to Parliament in the present session for an Act to make all necessary and usual provisions for effectuating such sale, for the distribution of the price thereof and the assets of the Company, and for the eventual winding up and dissolution of the Company, and that the directors be instructed to take all necessary steps for obtaining such Act. (3) To determine the provision to be made in such Act or otherwise for the appropriation and distribution of the reserve and renewal fund of the Company and the payments to be made to the directors and any officers and servants of the Company in recognition of their services. (4) That the Bill for the Act now submitted to the meeting be approved, subject to such additions, alterations, and variations as Parliament may think fit to make therein." Should the resolutions be passed by the required majority they will be submitted for confirmation as special resolutions to a second extraordinary meeting, which will be subsequently convened.

New Mains, etc., in London.—The report of the Highways Committee of the London County Council on Tuesday stated that the Council on May 28 formally disapproved of the works referred to in a notice of the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892 owing to the details being insufficient. Further details had now been supplied, and the committee recommended that sanction should be given. The committee also approved of an application from the Metropolitan Electric Supply Company to lay low-pressure concentric cables from the stage entrance of Drury-lane Theatre along the south side of Russell-street, the east side of Catherine-street, and the south side of Exeter-street to the Gaiety Theatre; and from the Notting Hill Electric Light Company to lay mains and to construct street boxes in Addison-crescent, in and across Addison-road, and in and across Kensington Park-road. A notice was received from the Vestry of Hampstead of intention to lay mains in Haverstock-hill, and in West Heath-road, Branch-hill, Frognall-rise, and Holly Bush-hill. The Vestry was the undertaker under the order, and the Council had no power of approval or disapproval of these works. Sanction was given for the House-to-House Electric Supply Company to lay mains on the north and west sides of Cornwall-mansions; for the Kensington and Knightsbridge Lighting Company to lay mains in Ovington-square; for the Westminster Electric Supply Corporation to lay mains on the north-east side of Upper Tachbrook-street; and for the Charing Cross and Strand Electricity Supply Corporation to lay mains across Panton-street.

Southport.—At the last meeting of the Town Council the Electricity Committee reported that they had held a meeting at which a report was read from Mr. Arthur Ellis, borough electrical engineer, upon the advantage which would accrue to the Corporation and consumers by the adoption of Wright's maximum-demand indicator, a system which has been adopted at Brighton and other places. The sub-committee recommended (*a*) that the principle of charging for electric current adopted in Brighton should be adopted in Southport; (*b*) that 7d. per unit should be charged for 365 hours on the maximum demand for electrical current during the half-year, that beyond that number of hours the charge should be at the rate of 4d. per unit; (*c*) that these charges should come into force on July 1 next; (*d*) and that the tariff should not apply to public street lighting. The committee resolved that the recommendation be adopted. Councillor Hesford, in moving the adoption of the minutes of the Elec tricity Committee, made reference to the above report. He gave a lengthy description of the maximum-demand meter by which the current would be measured. There were several modes of arriving at the charges to be made, but the one proposed was the one of the greatest excellence and with fewest faults. The mode was applicable to a consumer with one lamp or a thousand. The object of the resolutions to which he had referred was to increase the number of consumers of the electric light. It looked a great drop, but it would have the useful effect of encouraging consumers to take more light. Councillor Todd seconded the minutes, which were adopted after some discussion.

Telegraph Material for Central Africa.—There is being shipped in Glasgow Harbour, on board the steamer "Isle of Dursey," 250 miles of telegraph material, weighing over 400 tons, destined for Blantyre, Central Africa. There it will be used in the construction of Mr. Cecil Rhodes's telegraph line from Cape Town to Uganda. Southward from Blantyre the line has been practically completed, with the exception of a short stretch through Portuguese territory which intervenes in the district of the Zambesi. This portion will, however, be soon completed, when telegrams will be transmissible from Britain to Blantyre without interruption. The projected extension to the north, for which the material is now being shipped, will proceed from Blantyre by Lake Nyassa to Karonga, and thence to Abercorn, at the southern extremity of Lake Tanganyika, from which the line will pass along the western side of that waterway. The material is being taken out for the African Trans-Continental Company by the African Lakes Corporation of Glasgow, who have undertaken to deliver it at Chikwawa, which is situated on the Upper Shire, in British Central Africa. The ocean steamer "Isle of Dursey" will run alongside the African Lakes Corporation's floating hulk "Britannia," which is moored off Chinde, at the mouth of the Zambesi River. The telegraph material will be placed on board the "Britannia," whence it will be discharged into the corporation's stern-wheel steamers, and by this means conveyed along the Zambesi and the Shire Rivers. The telegraph posts are lightly made of steel, as wooden poles would soon be destroyed by the white ants which infest the district.

Bristol Tramways.—The new electric tramway between Bristol and Kingswood is rapidly approaching completion. The cars to St. George were taken off last week, and in their places 'buses are now being used to carry passengers, so that the work of reconstructing the line between the city and St. George's Church may not be interfered with. The same day as the cars ceased running workmen began to pull up the old rails and to relay the heavier and newer pattern ones. Unless the unforeseen happen, the relaying of the old line will be completed by the middle of July, when it is expected that the section between St. George's Church and Kingswood Church will be finished, the electrical apparatus fixed, and the new cars—the trucks of which have come from America—will be put together and in readiness for public use. The date of the opening of the line has not yet been fixed, nor can it be until the work is a little further advanced. The matter was alluded to at the meeting of the Bristol Sanitary Committee in connection with a memorial from the inhabitants of Old Market-street, who regard the present as a favourable time for the relaying of the thoroughfare with wood blocks, and the removal of the cab-stand and other structures which are alleged to disfigure the locality. The petition, however, is not likely to cause any delay to the tramway company's work for the committee have already selected the streets upon which money they have specially raised for wood paving shall be used, and Old Market-street is not included, and they cannot add to the list. The committee, however, sanctioned the laying of an additional track at the city end of Old Market-street, on condition of the lines on the east of Captain Carey's-lane being retained in their present positions.

Stafford.—The Electric Lighting Committee at the Town Council meeting recommended that the electric light mains should be extended from Greengate-street along St. Mary's-churchyard to Victoria-square, along Foregate-street to the general infirmary (in case the trustees of that institution decided to apply for the electric light), from the public baths to the junction of Newport and Lichfield roads, and from Greengate-street along St. Mary's-gate. Alderman W. H. Peach, in moving the adoption of the report, informed the Council that Mr. Lovatt had practically completed his contract for the buildings at the electric light station, and the boilers were also in a forward state. The committee found it advisable to somewhat restrict the contract for laying the mains from the idea originally proposed on account of the expense that would be incurred. With regard to the question of obtaining access to the works from the north side, the committee decided to leave the matter with the vice-chairman and himself. In company with Mr. Bell, they had had an interview with Messrs. Bostock, and after a long conversation they agreed to let the Corporation have a space of land by the side of their factory and 20ft. from the corner of the central station for £25, which would give all that was needed in the way of entrance. Alderman Silvester seconded the proposition. Mr. Smallman asked whether there was any cause for delay in the laying of the mains, because he noticed several of the workmen were walking about the streets. Alderman W. H. Peach replied that the reason was not apparent, but the men were certainly not remaining idle at the expense of the Corporation, the work being done by contract. He added that the committee hoped to be able to turn on the electric light during August at the latest.

Blackrock (Ireland).—A meeting of the Town Commissioners has been held, at which Mr. James Sweeney wrote complaining of the manner in which the tramway company were erecting the posts to carry the overhead electric wires. He stated they were erecting some of the posts in the middle of the footpaths, so that a person was in danger of striking up against them at night, and even in the daytime persons had to step out on the road. Mr. Goodbody said that he had called the attention of the Board to the subject at the last meeting and was told that the posts were not more than 4½in. from the side of the footpaths, but he found that the distance was 14in. He considered the position of the posts most objectionable; they should be placed close to the wall or at the edge. Mr. Hartigan said that they could not be placed close to the wall, as there was to be some ornamental castings placed at the base of the posts. The letter was referred to the engineer. The Township Secretary informed the Board that the tramway company had stopped running their cars between Blackrock and Kingstown, and the company were about to commence cutting up the road for the purpose of laying the electric tram line on that section. Mr. Goodbody said the company ought not to be allowed to move a single paving stone until they finished the section between Dublin and Blackrock. Mr. Canning proposed that the township engineer, Mr. Kough, C E, be instructed not to allow the tramway company to open the roads on the Kingstown section until the main street—Dublin section—was completed. Mr. Goodbody seconded the motion. The Chairman said that was the best way to meet the difficulty. Mr. Marchbanks said that they should not take any steps to prevent the company from proceeding with what

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he would call the grand work of laying the electric line through the township, which would be a great improvement. Mr. Kelly thought the best way to deal with the matter was to approach the tramway company in a friendly manner. The Chairman said that a committee had charge of the matter, and he would advise them to see the company that very day, or they might commence to open up the road at once. After some further discussion, the motion was withdrawn and the matter left in the hands of the committee.

Woodhouse and Rawson.—A meeting of the debenture holders in Woodhouse and Rawson, Limited, was held on the 13th inst. at Cannon-street Hotel, for the purpose of deciding whether their funds should be employed in taking action against the directors and auditors of the Company for the recovery of certain moneys which, in counsel's opinion, they were liable to refund. After discussion, the 10 per cent. debenture-holders decided unanimously against instituting legal proceedings, and the 6 per cent. debenture-holders voted in the same way by a majority of £32 650 stock to £3,900. The decision of the 5½ per cent. debenture-holders was postponed until Wednesday last, when they met at the official receiver's office, 33, Carey-street. Mr. C. J. Stewart, official receiver and liquidator presided and reported that at the former meeting held at Cannon-street Hotel, the 10 per cent debenture holders and a majority of the 6 per cent. debenture-holders voted against the institution of the proposed proceedings. Those two classes of creditors, however, expected to receive substantial dividends, but in the case of the 5½ per cent. debenture-holders there was no prospect of anything whatever in the shape of dividend, and the questions to consider were: (1) whether the proposed legal proceedings against the directors, etc., should be instituted; and (2) whether some arrangement could be made with the other classes of debenture-holders whereby the 5½ per cent. class would derive some benefit. He asked the meeting to regard the situation simply from a commercial standpoint, and to put away any vindictive feeling that might be felt against the directors. A resolution in favour of the proposed proceedings was moved, seconded, and discussed at some length, but upon a vote being taken it was declared to have been lost by a large majority.

Hanley.—A special meeting of the Town Council was held on Tuesday, when the Mayor (Alderman E. J. Hammersley), Mr. W. J. Carruthers-Wain (chairman of the North Staffordshire Tramways Company), Mr. W. H. Scott (general manager of the company), and Mr S. Sellon (electrical engineer) attended as a deputation to lay before the Council the views of the tramway company as to electric traction. A letter was received from Mr. J. G. B. Elliott, secretary to the tramways company, stating that the company had under consideration the adoption of some improved form of traction, and the directors were of opinion that the only form suitable for the district in which their lines were laid was that of electric traction by means of overhead wires. They desired, in the first instance, simply to obtain the consent of the local authority to the general principle, as they were assured that if reasonable conditions could be arranged with the local authorities the necessarily considerable amount of capital required would be available. The Corporation would appreciate the importance of the step to the company, inasmuch as it would involve the entire re-equipment of the line with cars and motors, and the provision of an expensive plant, but it was practically certain that no difficulties would arise as to the payment of interest and provision of sinking fund for the capital required to be raised, provided that some arrangements could be made with the Corporation in regard to the power of purchase of the lines in their district, which power they would be able to exercise in about seven years from new. The directors, having regard to the advantages of electric traction, were preparing a comprehensive scheme for extensions of their lines, including lines from Trent Vale to the London-road, Stoke, Newcastle to Hanley, Longport to Burslem, Goldenhill, and Tunstall to Burslem, and Smallthorne to Burslem. The Corporation would appreciate the fact that those lines, acting as feeders to the main line, would enable the whole system to be worked at a more moderate rate than if the main line were alone worked, and it was that, amongst other reasons, which induced the directors to have confidence in the success of the undertaking generally. He was desired to add that arrangements similar to those suggested in that letter had already been made in other towns where steam was being replaced by electricity—namely, Coventry, and West and East Hartlepool—and that with the Corporations an arrangement had been made whereby they had the power to purchase the generating station, plant, and equipment, with a reasonable allowance for depreciation, should they desire to purchase. The subject was fully discussed in committee, and afterwards a resolution was adopted approving generally of the company's scheme. The Local Government Board have notified the Council that they have sanctioned the raising of a loan of £5,000 for the purposes of electric lighting.

Milnrow.—A meeting of the Milnrow and Newhey District Council has been held, at which, in accordance with notice given at a previous meeting, Councillor Dawson moved: "That it is most desirable that this Council take into consideration the adoption of electric light supply works and maintenance for supplying the district with electric light, and, further, that application be made to the Board of Trade for a provisional order to erect and complete the same." Mr. Dawson said that at the meeting of the General Purposes Committee held in March last, among other accounts submitted he noticed one from the Milnrow Gas Company amounting to £191. 8s. On enquiry he learned that this was for the half-year ending February, and for gas supplied to 187 street lamps. He then stated that a considerable saving might be effected by the adoption of the electric light, and one or two members suggested that it would be advisable to obtain information on the matter. He undertook to get that information—of course, in his private capacity—and that night he proposed to explain detailed information which he had obtained, and which, in his opinion, justified the statement he made to the committee. He then read to the meeting a return of the present cost of lighting the district. Proceeding to refer to the electric light, he said that during the progress of his enquiries for information he found that previous to 1890 the bulk of the electric light supply was in the hands of private companies, the percentage being six private companies to one public body. In 1894, however, the order of things was reversed. The local authorities—seeing how profitable the business was—then took the lead, the percentage being 10 to 1. The Board of Trade fixed a maximum price of 8d. per unit for the light supplied to the public. The average annual consumption of units per light was 14, and this—at 8d. per unit—meant 9s. 4d. per year per light. He maintained that that was the poor man's light, because it was far cheaper than gas. He had prepared for their consideration four schemes, and he suggested that the best course to adopt would be to appoint a committee of three members from each ward, with the chairman as an ex-officio member, to consider the question. The Chairman said they all ought to thank Mr. Dawson for the large amount of information he had given them. He quite agreed that they should have a committee, but he thought that the latter part of the resolution with regard to applying for a provisional order would commit them to something. The Clerk thought it would be best if the committee considered the question before an application for a provisional order was made. Councillor Dawson said the Council were not bound to do anything even if they got a provisional order. However, he was quite willing that a committee should enquire into the matter first. Councillor Lamb seconded the resolution that a committee should be appointed (Councillor Dawson altering the original resolution so as to omit the latter part), and the proposal was unanimously assented to. A committee of nine members (three from each ward), with the chairman as an ex-officio member, was then appointed.

Walsall.—The Town Council have held a meeting, at which the following letter was read from the chairman of the South Staffordshire Tramway Company: "Your letter of May 14, addressed to the manager, containing a copy of a resolution passed at the quarterly meeting of your Council on May 13 was duly forwarded to me. Its consideration by the Board of this company has been somewhat delayed owing to my absence from England. It was, however, considered to-day by the directors, and I have to inform you that our manager has already been instructed to ascertain the views of other local authorities through whose district the cars run, as the arrangement of the seats of the cars was, I understand, approved by all the local authorities affected before they were constructed. Another difficulty is that the cars do not belong to us, and the owners (the Electric Construction Company) do not seem inclined to immediately make any alteration, because of the temporary nature of our agreement with them, and which we obtained, as you will remember, only by the kind offices of his Worship the Mayor of Walsall and yourself. You will, however, be pleased to hear that we hope in a short time to conclude a satisfactory and permanent agreement with the Electric Construction Company, and before your next quarterly meeting I hope to be able to inform you that the seats of the cars are in course of alteration. The present directors are, of course, in no way responsible for the arrangement of the seats, nor do they think such an arrangement should ever have been attempted, as it is a physical impossibility to comfortably seat three people abreast and provide a gangway inside a car which is to run on a 3ft. 6in. gauge. With regard to the overcrowding of the cars, instructions have already been given to the manager to increase the service, and with regard to the overcrowding, particularly on Saturday nights, I have given instructions that this should be carefully looked into, and that, if possible, more cars should be run at the hours the overcrowding occurs. If you have any information on this point, I shall esteem it a favour if you would be good enough to send it on to me, as the company has always received such consideration from the authorities of Walsall that I can assure you, on behalf of the Board, that it is their desire to comply with the wishes of the Walsall authorities and public in every way they possibly can."

Leeds Tramways.—The Sub-Highways (Tramways) Committee of the Leeds Corporation finally considered their report on haulage on Friday last, and having adopted it, and also the report of the city engineer, ordered copies of both to be sent to the members of the Highways Committee. The committee find that the difference in annual cost between the cable system of haulage and the overhead electric system, combined with a conduit in the centre of the city, will be £13,880 in favour of electricity. They also point out "that, whilst they are of opinion that the electric overhead system has passed the experimental stage, its possible advantages have doubtless not yet reached the maximum." They believe that electricity, in some form, will be the motive power of future tramways, and not only will the capital expenditure upon overhead electric traction be much smaller than upon the cable system, but in case of any alteration, or the subsequent adoption of a new method of electric traction, less loss would result in its adoption than would be sustained by a change from cable haulage to another system. Having regard to the many routes in Leeds, and to the great length of each, involving varying requirements as to frequency of service, the committee are unanimously of

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opinion that electric traction is the most suitable for the tramways of the city. Their recommendation to the Highways Committee is to this effect. A special meeting of that body for the consideration of their reports is to be held on Monday, the 24th inst., and should the documents be adopted, a copy will then be forwarded to each member of the City Council, with a view to the question of haulage being finally settled. The city engineer was recently asked to report as to the cost of providing an electric conduit for the centre of the city—say, to the dispensary in North-street the junction of Hunslet-lane with Hunslet New-road, the end of Queen-street, in Wellington street, and the top of Park-row—and to state the advantage of, and objections to, such conduit As the tramways are a double track in each of these lengths, the total length of electric conduit required would (says Mr. Hewson) be 2 77 miles. He computes that total additional capital required for the substitution would be £10,183, and taking all the *pros* and *cons*. into account, he thinks that a penny, or a little over, per car mile, would represent the excess of cost of running the conduit system over the electric overhead system. He therefore puts the total approximate extra annual cost of electric conduit over electric overhead for the above-mentioned central portions of the track at £2,230. The difficulties and objections to the electric conduit system are, he says, an occasional stoppage of the cars through short-circuiting, brought about by adventitious matter finding its way into the conduit; a wide slot, dangerous to narrow wheels, unless an improvement on the Budapest system is made; frequent obstruction of the traffic of the most crowded streets of the city by taking them up for the repair of the electrical portion of the conduit. He adds, that unless very effective automatic machinery can be made to do the work, there will necessarily be, with a service so frequent as 1½ minutes, an interference with the traffic in passing the cars from one system to another, and there would be 10 of such changing places.

Worcester.—The Electricity Committee recommended the City Council at its last meeting to fix the following charges for electric arc lamps for street-lighting: all-night lamps £25, and half-night lamps £15. 10s. per annum. In moving the adoption of the recommendation, the Deputy-Mayor said that brought the charge down to an average of £20. 5s., and was a reduction on the charge which the committee made in the first place of £74 a year. When the committee went fully into the matter, and had information from a great many other districts, they found, considering that they had water power, that they would be justified in making such a low charge as that proposed. The maximum charge for arc lamps ismilar to those at Worcester was £45, and the lowest was £20. Alderman Holland seconded. Mr. Rushton said six gas lamps had been taken away between the Cathedral and Pump-street, and four electric lamps put in their place. They would cost £100 a year, as against £18 a year for the gas The recommendation was adopted. A resolution was passed, on the recommendation of the Electricity Committee, agreeing to remove at three months' notice, and to make good damage done to the property, an incandescent electric light bracket which Alderman Ernest Day had allowed to be erected on the corner of his house 22, Pump street, and the Deputy-Mayor thanked Alderman Day for agreeing to the proposal. A question was asked by Mr. Rushton as to an account of £72. 19s. 7d. from Messrs. Underwood for coal. Last month there was an account for £104. 10s 3d. He asked whether the present account was for the monthly supply of coal at the generating station. Mr. Williamson explained that the coal was supplied by Messrs. Underwood on the order of the late engineer of the electrical works without any instructions from the committee, and the committee refused to pay for the coal until they wanted to use it. The firm had had to wait for six months for their money. The City Engineer (Mr. Caink) disputed the deputy-mayor's statement, and said he ordered no coal without the authority of the committee. The coal was sent without any order from him, and that was the reason the committee very properly refused to pay. Mr. Williamson promised to submit a report as to the consumption of coal at the generating station at the next meeting. The payment of the account was authorised. Mr. Charge referred to an account of £2,000 to be paid to the Brush Electrical Engineering Company as the eighth instalment on account of the contract for laying mains, etc., and asked whether this was limited to the contract, or whether the committee had power to go beyond the contract and pay for any extras that might be incurred without the sanction of the Council? The Deputy-Mayor said he took it that they had no power to pay anything without the sanction of the Council. Mr. Millington said the Council had sanctioned works by the Brush Company amounting to £27,059—£23 109 being for mains, £1,861 for street-lighting, and £2 089 for waterworks pumping. If the Council passed the present bill they would have paid £23,560, so they were well within the mark The Town Clerk, upon the terms of a resolution passed last September, and referred to by Mr. Charge, said the chairman of the committee would be justified in signing anything certified by the engineer for payment. The Library and Museum Committee recommended the acceptance of the amended tender of the New British Installation Contractors, at £786, for wiring the Victoria Institute for the electric light. Mr. Chaplin moved the adoption of the recommendation. Alderman Buck moved that the tender of Messrs. Graham and Biddle, London, at £768, be accepted. He said he thought the committee had made a mistake in allowing one of the parties who tendered to correct an error in the way they did. It was most important that the Council should at once correct that error, not only to deal fairly with Messrs. Graham and Biddle, but for the future, because if the recommendation was adopted he could hardly anticipate that any people outside would tender for any work the Council might have to do. It was perfectly consistent, if a man found he had made a mistake to allow him to withdraw his tender, but he did not understand on what ground they could allow him to amend it. Mr. Lewis seconded. On a division the amendment was carried by 13 votes to 12.

Taunton—A meeting of the Town Council has been held, at which the Electric Lighting Committee reported that the cable of No. 1 circuit had been laid underground and all the posts and overhead wires removed. Also that a report had been received from Dr. Fleming, in which he stated: "In accordance with your request, I visited Taunton on May 8 and made an inspection of the electric lighting station and of the new work carried out this last year in connection with the establishment of the second transformer sub-station and the laying of the mains connected with it. I found the supply station in good working order and the whole of the plant carefully looked after. I inspected the second sub-station, and found the work there had been carried out in a thoroughly workmanlike manner. Two 30 kilowatt transformers are now in operation in this second station supplying by the underground system of distributing mains connected to it. A considerable section of the arc-lighting lines has also been put underground, and this work has been carried out in accordance with certain special requirements of the electrical adviser of the Board of Trade The whole of this cable work has been carried out by Messrs. Fowler, Waring, and Co., in a satisfactory manner under the superintendence of your borough surveyor and electrical engineer. I may remark, in passing, that in laying these mains and selecting a system of underground conductors for use at Taunton I have avoided the use of all junction-boxes and open conduits, in which gas could accumulate I decided to employ triple-concentric cable sheathed with lead and covered with steel plate. The whole of the distributing mains and the house connections are laid without any junction-boxes or open spaces in which gas could accumulate, and there need, therefore, be no apprehension on this point. The two sub-stations, Nos. 1 and 2, are now in excellent working order. I am anxious that a trial of the demand-meter system, invented by Mr. Wright, of Brighton, should be given at Taunton. I have next to consider in what direction further extensions should take place. I do not think that at the present moment the demand for light in East-street justifies you in putting down a third sub-station, although this will ultimately have to be done. There are three matters which ought to take precedence of this. In the first place, it is essential to remodel the switchboard in the station. It is necessary that the engineer in charge should now be able to switch any machine on to any circuit instantly and without danger, and that as the demand for current gets less, the whole of the circuits may be gathered together on to the small machine. The present switchboard, I consider, is not properly provided with instruments to enable this to be done with ease and certainty. I suggest therefore to you that an invitation to tender should be put out for a station switchboard in accordance with the specification which I send with this on a separate sheet. In the next place, I want to draw your attention to the fact that at the present moment the demand for light fully fills up the capacity of the present plant. The lamps installed are at the present moment 2 100; this load can only just be taken on one of the large machines and a small one. If in the course of next winter an extension of 500 or 600 lights takes place—and which we may assume will be the case, having regard to the rate of progress during last winter—then the station would be left without proper reserve plant. It will be necessary therefore for you to consider very soon obtaining a tender for a fourth engine and alternator. I have considered carefully what form this should take. An economy in space would result from the employment of a direct-driven alternator, and there would be no objection to the employment of this method of driving, since each machine is necessarily independent. I suggest, therefore, the tenders for the supply of this alternator and engine should be invited, but that those who tender for the alternator should have the option of either driving it by belt or direct. I have considered whether it is possible to extend the private lighting by laying a short underground high-tension cable to the Crescent. If, as I understand, there is some considerable quantity of private lighting to be obtained in this part. then I think that a high-tension cable, 7-16th in size, should be laid down, and a service should be given to house transformers placed in this part if promises of consumption can be obtained. It is very desirable to supplement the shop-lighting by as much private lighting as possible, because the private lighting continues farther into the night. I therefore advise that a canvass should be made, and that information should be obtained whether any number of consumers can be obtained in the Crescent. Also that your borough and electrical engineers should report to you what it would cost to lay down a 7-16th high-tension cable from the No. 1 sub station along the Corporation street and Crescent, and give a supply by house transformers where required. It is necessary to take all possible steps to push the private house-lighting as the tendency of the shop-lighting is towards shorter hours. Your street arc lighting is so good that the shops along the route of the arc lights take advantage of it to illuminate their shop fronts, and do not use their incandescent lamps as much as they would do if there were no arc lighting. The new Board of Trade regulations are intended to be more stringent as regards the use of high-tension private arc lamps, and it will be at no distant date necessary to provide all the private arc lighting off the incandescent lighting circuits, or, better still, to encourage the use of high candle-power incandescent lamps for the purpose. In addition to this, the new rules require that each street arc lamp should be capable of being separately extinguished and cut out of circuit. Mr. Couzens has devised a switch for this

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purpose which, it seems to me, deserves a trial. I recommend that six of these switches be procured and fitted at once to six street arc lamps, and if proved satisfactory after three months, the whole of the street lamps must be so fitted." On the motion of Councillor Potter, seconded by Alderman Trump, the report of the committee was adopted. Councillor Webber said that he saw in the special report all the elements of a large expenditure in the future. He took exception to one part of Dr. Fleming's report – viz., that although they had borrowed £5,000 to extend the light, the residents in East reach were to be neglected, whilst a solitary place like the Crescent was to be looked after because three members of the Lighting Committee lived there. The Mayor pointed out that they were not then asked to adopt Mr. Fleming's report. Councillor Potter said the committee had no intention of departing from the decision to put additional arc lamps in East-reach. It was the private lighting that Dr. Fleming referred to, as it would not pay them to put down a sub-station until the private lighting increased. The speaker said he felt bound to mention that Dr. Fleming expressed to the committee his great satisfaction at the way in which all the plant was kept at the depôt. Colonel Hasted, when he held the enquiry at Taunton, also said he never saw a place of the sort kept in a better condition. The Mayor mentioned that he met Dr. Fleming for the first time a few days previous, and he much struck with him and considered they were fortunate in having such an adviser.

PROVISIONAL PATENTS, 1895.

JUNE 10.

11355. **Improvements in or connected with electric cables.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

JUNE 11.

11358. **Improvements in electric switches.** Edward Jesse Piper, 34, Victoria-street, Westminster.

11375. **A covering for electric wires.** Franklin Streater Randall and John Shallcross, 70, Wellington-street, Glasgow. (Complete specification.)

11399. **Arc lamp.** Samuel Pleasants Parmly, 46, Lincoln's-inn-fields, London. (Complete specification.)

11414. **Improvements in and relating to soundless voice-conveyors for telephones.** Walter William Scott, Prince's-chambers, Wolverhampton,

11434. **Improvements in telephony.** Charles Adams-Randall, 1, The Avenue, Bedford Park, London.

JUNE 12.

11449. **An improved grip to be employed in laying electric cables.** Robert Middlemass, Peasholme House, Scarborough.

11478. **Improvements in apparatus for the electrolytical separation of precious metals from their ores or other materials containing them.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Louis Pelatan, France; and Fabrizio Clerici, Italy.) (Complete specification.)

11482. **Improvements in automatic repetition on telegraph, cable, and other lines.** Herbert Arnaud Taylor and Joseph Arthur Lovel Dearlove, 24, Southampton buildings, Chancery-lane, London.

JUNE 13.

11516. **Improvements in fittings for electric lamps.** Charles Hopkinson, 17, St. Ann's-square, Manchester.

11528. **Improvements in and relating to insulators for electrical purposes.** Alfred James Perton Whitaker and Frederick Gwilym Treharne, 45, Southampton-buildings, Chancery-lane, London.

11540. **Improved electric primer.** The Morris Tube Ammunition and Safety Range Company, Limited, and Arthur James Herney Wyatt, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11544. **Improvements in the manufacture of the insulator arms of telegraph poles and poles for carrying conductors of electricity generally.** Bullers, Limited, and Edward John Chambers, 7, Staple-inn, London.

11547. **Improvements in and connected with apparatus for coating strips, wire, and like metal articles by electro-deposition.** The Cowper-Coles Galvanising Syndicate, Limited, Sherard Osborn Cowper-Coles, and William Pole Routh, 47, Lincoln's-inn-fields, London.

11548. **Improvements in telephone systems.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

11549. **Improvements in telephone systems.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

11555. **Improved means for opening and closing doors by electricity.** Solomon Cambie, 76, Chancery-lane, London.

11558. **Tee junction pipe clips for electric mains and services.** Ernest Mercer and John James Glass, 166, Fleet-street, London.

11560. **Improvements in or connected with electric mains or conductors.** James George Willcox Aldridge, 40, Chancery-lane, London.

JUNE 14.

11594. **Improvements in telephone receiver fittings.** Max Binswanger and Francis George Bell, 73, St. Stephen's-road, Upton Park, London.

11633. **Improvements in or connected with ceiling roses, lampholders, and other electrical fittings.** Charles William Rea Campbell, 54, Fleet-street, London.

11641. **Improvements in electrical alarums.** Henry Laville and Joseph Plisnier, 97, Newgate street, London.

JUNE 15.

11659. **Improvements in elements for secondary batteries.** Job Thomas Niblett, 20, Devonshire-road, Greenwich, London.

11672. **The positive and negative lightning conductor.** James George Vine, 14, Glen Eagle road, Streatham, London.

11700. **Improvements in alternating-current machines.** Walter Claud Johnson and Louis John Steele, 28, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1894.

4021. **Telephone transmitters.** Brown.

8539. **Telephone exchange system.** Andreoli. (Raverot and another.)

10032. **Electrolysis.** Gautier.

10701. **Electrical connections for marine purposes.** Snell.

11286. **Electric lamps.** Holden.

13581. **Electric cables.** Thompson.

1895.

2430. **Insulating electric conductors.** Hardingham. (Felten and Guilleaume.)

2914. **Electric distribution.** Devonshire. (Steinmitz.)

4257. **Electric arc lamps.** Thompson. (Mathiesen.)

5428. **Electric transmitting thermometer.** Denison.

6007. **Electrically-propelled railway trains.** Siemens Bros. and Co. (Siemens and Halske.)

7625. **Electric wire insulators.** Rothenberger and others.

8026. **Electric railway systems.** Faulkner.

8147. **Driving electric cars.** Nees.

8226. **Electric batteries.** Von der Poppenburg.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Brush Company, Ordinary	3	2⅛-2¼
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ Debenture Stock	100	112-115
Charing Cross and Strand	5	5¼-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	15⅞-16¼
—— 5 per cent. Debenture Stock	100	133-136
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2¼
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	—
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	93-97
—— 7 per cent. Cumulative Pref.	2	1⅛-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1⅛
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	⅛-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	10½-11½
—— Preference	10	14-15
—— 4½ per cent. Debentures	100	103-106
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅞-7⅞
—— Pref.	—	—
Liverpool Overhead Railway	10	9 15/16-10 1/16
—— Pref.	10	14⅜-15½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	⅛-¼
Metropolitan Electric Supply	10	10⅜-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	5¼-5⅜
—— 6 per cent. Cum. First Pref.	10	15¾-16½
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Nom. Cum. Third Pref.	5	5⅜-6
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8-8½
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5¾-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8¾
—— 7 per cent. Pref.	5	8¾-9¼
Swan United Ordinary	3	1⅞-2⅛
—— 4½ per cent. Debentures	100	105-108
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7⅞-8⅛
Yorkshire House-to-House		5½-5¾

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NOTES.

Institution of Electrical Engineers.—The conversazione of the Institution will be held in the galleries of the Royal Institution of Painters in Water Colours, 191, Piccadilly, W., on Wednesday evening, July 3, from 9 to 12 o'clock.

Electric Train-Lighting.—The lighting of certain trains on the Marienburg-Mlavka Railway by means of accumulators has given satisfaction, and the directors have, therefore, resolved to electrically light all their trains. The storage batteries used are those of the Kölner Akkumulatorenfabrik Gottfried Hagen, of Kalk, Cologne.

"Thomsistas."—This peculiar word has been invented by a Spanish writer in *El Telegrafista Español* in an article in which he advocates the establishment in Madrid of a practical school for the purpose of teaching students the working of the Thomson receiving instrument. It seems that such an *escuela de thomsistas* already exists in Cadiz.

Electrozone Plant.—The Philadelphia (U.S.A.) Board of Health have determined to instal an electrical plant for the manufacture of electrozone according to Mr. A. E. Woolf's process. The plant, with a capacity of 1,000 gallons per hour, will be placed in the basement of the Municipal Buildings, and the product will be used for sprinkling the streets and for general disinfecting purposes.

New Budapest Electric Railway Scheme.—Herr Ludwig Schiller, director of the Budapest-Neupest-Rakospalota Electric Railway, and Prof. Carl Zipernowsky, director of the electrotechnical department of Messrs. Ganz and Co., have requested from the Hungarian Ministry of Trade and the municipal authorities of Budapest a concession for the construction of a metropolitan electric railway in that city.

Municipalisation and Nationalisation of Telephones.—Upon the expiry of the concession which was accorded to the Bell Company, the municipal authorities of Amsterdam have decided to take the working of the city telephones into their own hands. The concession expires shortly. It is also worthy of note that the Austrian Government has made arrangements to take over the Vienna telephone lines of the Privat-Telegraphengesellschaft.

Electrical Journalism.—On June 11 notice was given by the authorities of Somerset House that the Electricity and Electrical Engineering Newspaper Company, Limited, had been struck off the register and dissolved. This, of course, does not in any way affect the present position of our contemporary, the entire undertaking having been purchased from the company by Mr. S. Rentell, A.I.E.E., more than 18 months ago, and successfully carried on by him ever since.

Amalgamation of Zinc Plates.—The *Elektrochemische Zeitschrift* gives the following method of amalgamating battery zincs: To a saturated solution of neutral sulphate of mercury are added sufficient sulphuric acid to completely dissolve the mercury, and oxalic acid, the result being a liquid of the consistency of cream, then a little sal-ammoniac. The zinc plates are immersed in the mixture and afterwards vigorously rubbed. If they are not immediately used they should be carefully dried.

North-East Coast Institution.—We have received parts 7 and 8 of vol. xi. of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders, which contains the reports of the adjourned discussion on Mr. Henry Foster's paper on "The Application of the Electric Arc to Machinery and Boiler Repairs"; of the adjourned discussion on Mr. S. O. Kendall's paper on "Turret-Deck Cargo Steamers"; and a paper on "The Metric System of Weights and Measures," by Mr. G. H. Baines, with discussion.

The Pacific Cable.—A Reuter's telegram from Brisbane states that, in opening Parliament, Sir H. W. Norman, the governor, in his speech on the occasion, said that the Pacific cable question is receiving the most earnest consideration, and should the researches of the proposed joint commission of Great Britain, Canada, and Australia justify it, and should the other Australian colonies show further hesitation, Queensland would be prepared to recommend that the Pacific cable be constructed by Great Britain, Canada, and Queensland alone.

The Electric Light in St. Petersburg.—Two further streets in St. Petersburg, the Millionnaya and the Moskva-Pereulok, are to be lighted by electricity. The work is to be carried out by the firm Goné and Co., representatives of the Allgemeine Elektricitäts-Gesellschaft, of Berlin. The 800-ampere dynamos will be driven by two Marshall engines, steam for which will be supplied by water-tube boilers. The 1,200-c.p. arc lamps will be suspended from wires fastened to the houses on each side of the thoroughfares, in order to avoid the shadows cast by poles.

Northern Society of Electrical Engineers.—We have received the *Proceedings* of this society for the past year. The contents include a paper on the "Blackpool Electricity Works," by Mr. John Hesketh, with discussion "Notes on Designing a System of Underground Electric Light Mains," by Mr. John H. Rider, with discussion "Electricity Meters," by Mr. R. P. Wilson, with discussion "Lighting Installations," by Mr. H. A. Henderson, with discussion; "The Commercial Possibilities of Accumulators for Tramcar Traction Considered as a Municipa Undertaking," by Mr. Alfred H. Gibbings, with discussion.

The Reaction of the Armature Current in Continuous-Current Dynamos.—This was the title of a paper which Herr W. Lahmeyer read before a recent meeting of the Frankfort Elektrotechnische Gesellschaft. He succeeded, he said, in 1888, in entirely obviating the reaction of the armature current in his dynamos. It had even become possible, by means of new methods, both in continuous and alternating current machines, to cause the armature current to assist the magnetism of the dynamo. The author detailed, in conclusion, how a continuous-current dynamo could be made with no winding at all on the fixed magnets. This dynamo, however, was more original than practical.

Extraordinary Resuscitation.—A New York telegram, dated 21st inst., ran: "To-day, at Rochester, New York, an employé of an electric company, named Frank Grover, aged 33, accidentally received an electric discharge of between two and three thousand volts, or nearly three times the force considered necessary for the electrocution of condemned criminals. For fully three-quarters of an hour he lay apparently dead, with his right leg and arms terribly burnt. Finally, however, after 90 minutes' exertion by a physician and three of Grover's fellow-workmen, he was sufficiently restored to be transferred to his home." It is to be hoped that the statements made are more correct than is the English of the message.

Long-Distance Telephones.—It is stated that the telephonic communication established between London and Manchester, Glasgow, and other large centres will not be placed at the disposal of the general public before the middle of next month. A serious difficulty has arisen owing to induction. When the new trunk lines were tested

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last Wednesday week the success of the experiments was due to the fact that only one or two circuits were being tried simultaneously, but when all the circuits are in operation the induction set up becomes very inconvenient. Everything that is possible will be done to minimise the difficulty, and an endeavour will be made to establish three offices in London for the despatch and receipt of long-distance messages.

Originality.—According to an American contemporary, it is proposed to do away with the smoke nuisance in Pittsburg by erecting at some convenient coal mine a mammoth electric power plant to furnish the city with current for electric lighting, heating, and power, thus entirely doing away with the burning of coal in and immediately about Pittsburg. We are informed that "it is thought by Mr. Robert Marshall, of the firm of Marshall Bros., elevator builders, the originator of the scheme, that electricity could be furnished from such a plant cheaper than power could be generated in isolated city plants." How any claim can be set up for Mr. Marshall as the originator of such a scheme it is difficult to understand. It is simply an adaptation of the proposal made long since by Mr. B. H. Thwaite, of Liverpool.

Scottish Institution of Engineers.—We are in receipt of the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland, which contains a report of the annual general meeting held in April last, including a paper on "A New Departure in Steam-engine Economy, with a Description and Tests of Field's Combined Steam and Hot-Air Engine," by Prof. Andrew Jamieson, M.I.C.E., F.R.S.E.; the resumed discussion on Mr. W. Carlile Wallace's paper on "Electrical Transmission of Power in Shipyards and on Board Merchant Steamers"; and discussions on Mr. W. David Archer's "The Strength of Ships' Beams"; Mr. James M. Gale's "Extension of the Loch Katrine Waterworks"; and Mr. Archibald Denny's "The Drawing Office." Mr. W. D. Archer expressed his approval of introducing the electric light into drawing offices.

Recreation.—Prof. W. E. Ayrton and Mrs. Ayrton gave an "At Home" on Friday last, which was largely attended by the leading men in the electrical industry. We understand that many of the students at the Central Institution were also invited, and in this way got introduced to those who have made the industry what it is. The social side has never been neglected by Prof. Ayrton. We do not hold with these gentlemen that after-dinner speaking is more useful than good work done, but commend all attempts to bring the rising young men into touch with those who deservedly hold high positions in the profession. Among the guests present last Friday were Prof. A. B. W. Kennedy, F.R.S., Mr. J. W. Swan, Prof. G. Forbes, F.R.S., Prof. W. Crookes, F.R.S., Prof. O. Henrici, F.R.S., Prof. S. P. Thompson, F.R.S., Prof. J. Perry, F.R.S., Dr. W. Sumpner, Mr. F. H. Webb, etc.

The Hermite Process.—Dr. W. Hill Climo, brigade-surgeon, lieutenant-colonel, Army Medical Service, (retired), in dealing with the subject of "Malta Fever in Relation to Local Sanitary Conditions," writes that "as long as the harbours of Malta are allowed to continue in their present state there must always be sanitary risk and danger to the public health. Moreover, as these conditions are mainly caused by our own navy and by our mercantile marine, while they are not remedied, by what right can we impose sanitary obligations on the civil population? Certainly none. It is a case of putting our own house in order first. The proposal, then, is that the sewage, etc., of our ships should be disinfected and rendered innocuous before being poured into the harbours of Malta by the electrolysis of sea water. No better locality could be selected for the trial of the Hermite process than in those harbours and in the Suez Canal."

The Railway Congress.—The Prince of Wales on Wednesday opened, at the Imperial Institute, the International Railway Congress, which first met at Brussels in 1885, then at Milan in 1887, at Paris in 1889, and at St. Petersburg in 1892. For business purposes the congress will meet on Monday, July 1, and continue its sittings until July 9. The remainder of this week will be spent in visits to several important railway works, and various entertainments have been arranged for the guests. The Prince was received by Sir Andrew Fairbairn, a director of the Great Northern Railway and president of the English section; Lord Emlyn, deputy-chairman Great Western Railway, vice-president; the committee (consisting of the chairman, directors, and general managers of all the principal railways in the United Kingdom); Sir Courtenay Boyle, secretary of the Board of Trade, and other gentlemen interested in railway work.

New Telephone Transmitter.—Mr. C. F. Dunderdale, of Chicago, has recently brought out a type of telephone transmitter possessing some novel features. While recognising the good qualities of a granular carbon in a transmitter, the tendency to packing has to be avoided, and this he has secured by means of a constant rotation of the case containing the granules, so that the carbon granules are in a constant state of reversal of position, thus preventing their settling and the ensuing separation of the grains, the finer from the coarser, the former collecting at the bottom and the latter at the top, which the shaking only aggravated and increased the tendency to solidify. One of the means of accomplishing this result is to provide a lever and ratchet movement, the lever being the support hook of the receiver, the act of hanging up and taking down of which causes the rotation to be secured automatically. It is stated that every characteristic of the voice is preserved, whether the transmitter is shouted at or whispered into, all extra vibratory sounds or echoes being eliminated.

Iron and Steel Institute.—In view of the holding of the autumn meeting of the Iron and Steel Institute in Birmingham on August 20, 21, and 22, the South Staffordshire Ironmasters' Association have held a meeting in Birmingham for the purpose of making preliminary arrangements. Sir Benjamin Hingley, M.P., said it was 24 years since the institute had met in that district. He suggested that after the reading of scientific papers on the development of the trade and on other matters of interest to the general body of the members, they might visit some of the leading places in Birmingham and the neighbourhood. The Mayor of Birmingham had consented to welcome the members and to hold a reception in the Council House. Lord and Lady Warwick had promised to receive them on the second day, and Sir Arthur Hodgson and Mr. Edgar Flower would give them a hearty welcome to Stratford-on-Avon and open the Shakespearean Theatre. The Chairman concluded by moving that a general reception committee should be appointed. Mr. Arthur Keen seconded the motion, which was carried. The Chairman said that £1,000 would cover the expenses, and £760 was subscribed in the room.

Society of German Electrical Engineers.—At the third annual meeting of the Verband Deutscher Elektrotechniker, which is to be held in Munich on July 5-7 next, reports of commissions will be presented on: (1) "The Introduction of Uniform Sizes of Contacts and Screws"; (2) "The Avoidance of Misunderstandings in Tendering"; (3) "Safety Rules for Electrical Installations"; and the following papers will be read: "The

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Dubiau Pumps," by Herr F. Ross; "The Munich Electricity Works," by Herr F. Uppenborn; "Comparative Studies of Acetylene, Gaslight, and the Electric Arc Light," by Dr. W. Wedding; "The Circuit Law," by Dr. K. Heinke; "Electrical Cooking Apparatus," by Herr Paul Stotz; "The Behaviour of Transformers under the Influence of Alternating Currents of Various Periodicities," by Dr. G. Rössler; "Electric Meters," by Herr G. Hummel; "Obtaining Electricity by Chemical and Thermo-chemical Methods," by Dr. O. Schmidt; "Equipotential Lines in Magnetised Plates," by Dr. von Lommel; and "The Distribution of Radiation Energy," by Dr. L. Grätz. On July 6 the municipal electricity works, and on July 7 the electrical installation at the Central Railway Station, will be visited.

Chesterfield and Midland Counties Institution of Engineers.—The annual general meeting of this institution, coupled with an excursion, will be held in the town of Warwick on Saturday, July 13, at 1 p.m. The party will assemble at the railway station, Coventry, on the arrival of train due 11.26 a.m., and will proceed in brakes, specially engaged, by road *viâ* Stoneleigh Abbey to Warwick. Immediately on arrival the general meeting will be held in the Court House, the use of which has been granted by the mayor, the Earl of Warwick. The election of officers for the year 1895-6 will be determined by scrutineers of the voting papers appointed by the meeting. New members elected by ballot will be announced. The general report of the council, and their finance report, with abstract of the audited accounts of the past year, will be presented for discussion and adoption. A printed copy will have been sent to each member. The president-elect (Mr Emerson Bainbridge) will deliver an address from the chair. The following paper will be read or taken as read: "Photometric Value of, and Notes upon, Various Illuminants Used in Mines," by Mr. A. H. Stokes. The limited time at disposal will not allow of discussion upon papers read at previous meetings, but members are invited to contribute communications thereon by letter. Luncheon at the Warwick Arms, 2.30 p.m.

Cheap Electricity in Germany!—A paragraph is going round the German daily papers to the effect that the Frankfort Electricity Works purpose supplying electrical energy at the price of six pfennige (¾d.) per 1,000 watt-hours. The *Elektrotechnischer Anzeiger* remarks that, to its knowledge, the cheapest electric power is that furnished by the Isar Works, near Munich, at 10 pfennige (1·2d.) per 1,000 watt-hours, but these works have the advantage of the water power of the Isar, and the German technical journal naturally throws doubt on the Frankfort announcement. A later number of the same bi-weekly technical journal, however, confirms the above-named price, which, nevertheless, applies only to current used for power purposes. The lessees of the Frankfort Electricity Works (Messrs. Brown, Boveri, and Co.) write: "The very low price offered of 6·5 pfennige per 1,000 watt-hours is based upon an extremely heavy yearly consumption, amounting to at least a million kilowatt-hours for, say, a 24 hours' run of a 150-h.p. motor. This price can be fixed because the demand on the central station chiefly occurs at times when there is not much other work doing, and when a heavier load on the machines favourably influences the running. By this consumption the working cost of the station per kilowatt-hour is substantially reduced, and this is a preliminary step towards cheapening the price of light."

Electric Meter Trials in Paris.—Particulars have been published in *Bulletin* No. 3, 1895, of the Association Amicale des Ingénieurs Electriciens de Paris, of a series of electric meter trials which were recently carried out by a commission, at the head of which were MM. E. Sartiaux and J. Laffargue. The experiments were confined to the meters used in the metropolis—namely, those on the Thomson, Aron, Frager, Brillié, and Déjardin systems. Observations kept on about 500 Thomson meters in service showed that there were 4½ per cent. of failures, of which 2 per cent. were due to dust on the disc, 1½ per cent. to loosening of the endless screw, and 1 per cent. to various causes—bad connections, burnt wires, etc. There were, moreover, several cases of faulty casings, which allowed dust to penetrate into the interior of the meter. The Aron meter, the commission state, requires great care in its construction and numerous precautions have to be taken in using it. Failures in this instrument have been to the extent of 15 per cent. The commission, nevertheless, say that the Aron meter has given very satisfactory results in Paris, but it has to be well looked after. The Frager meter presents many inconveniences. The Brillié instrument has yielded good results in practice, but it, too, necessitates much watching; its mechanism is very delicate, and of very small dimensions. The Déjardin meter, which is "a very simple machine," has been "working with regularity" in one of the Parisian districts. In concluding their report, the commission complain that makers have not exercised that care in turning out the later instruments which they used in producing the first meters for trial.

The Telephone Service.—In common, we presume, with other subscribers, says the *Financial Times*, we have received from the National Telephone Company the following minatory circular: "Notice to subscribers—It has been brought to the company's notice that in several cases subscribers are habitually allowing non-subscribers to use their instruments, and in other cases subscribers have received messages on behalf of non-subscribers, and sent their clerks out to deliver such messages. Such practices are not only a violation of the agreement enter into by the subscriber with the company, but also contravene the license of the Postmaster-General, under which subscribers are enabled to have exchange facilities, and the company have power under their agreement to cancel the contract of any subscriber who disregards the above-mentioned conditions. The company feel that it is only necessary to call its subscribers' attention to these irregularities to ensure their discontinuance in the future.—Wm. E. L. Gaine, general manager. Head Offices, Oxford-court, Cannon-street, E.C." As we have not been guilty of the criminal conduct referred to, our conscience is easy, but the occasion seems a suitable one for the issue of a circular which we have had in contemplation. Here it is: "Notice to the company—It is within our knowledge that in many cases subscribers are habitually unable to use their instruments owing to defects in the company's system, and to the arbitrary conduct of the operators. In other cases, and owing to the same causes, subscribers are continually receiving messages not intended for them, while the voice of the subscriber with whom they are supposed to be in communication is inaudible. Such a state of affairs is not only a violation of the understanding which leads one to become a subscriber, but also fully justifies the action of the Postmaster-General and others in trying to make some fresh arrangement which will ensure that subscribers shall have the exchange facilities they pay for. The subscribers have power to refuse to renew their contracts, and many of them would do so were it not that they hope for a better state of affairs as the result of the select committee's report. The subscribers would feel—were it not that experience has proved the contrary—that it would only be necessary to call the com-

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pany's attention to the inefficiency of its service in order to secure its improvement in the future."

Personal.—Mr. John Gordon Longbottom, who has been appointed by the governors of the Glasgow and West of Scotland Technical College to the Lectureship in Mechanics in the college, is 25 years of age. He served an apprenticeship of six years in the various departments of the works of Messrs. F. and J. Butterfield and Co., Limited, engineers and machine tool makers, Keighley, during which time he was successful in the competition for Whitworth exhibitions (1889). By the aid of a national scholarship gained in 1890 he had a three years' course of training in science at the Royal College of Science, London, and at the final examinations of the session 1891-2 in the advanced courses of mechanics and machine design he was placed in the first position, being awarded the prize and first-class associateship of the college in mechanics. In 1893 he gained a Whitworth scholarship, being placed second on the list. He was also an associate member of the Institution of Mechanical Engineers. Amongst numerous certificates and medals held from the Science and Art Department there are first-class honours, certificates, and medals in machine construction and drawing; theoretical mechanics and first place in first-class honours applied mathematics in 1893; first-class certificates in mathematics, also honours certificates in practical, plane, and solid geometry, sound, light, and heat, etc. After winning the Whitworth scholarship, he attended the engineering courses at University College, London, and spent some considerable time in practical laboratory work, and at the final examination of the senior classes in the theory of elasticity and dynamics last session he was awarded the prize. During the year of his scholarship he made a special study of those higher branches of mechanics most useful from an engineer-point of view, such as advanced theory of elasticity, theory of arched ribs, metal domes, masonry and brickwork arches and domes, continuous beams, struts, theory and strength of cylindrical and spherical shells with especial application to guns, flues, and boilers, pressure of earthwork on supporting walls, etc. He also had experience as a demonstrator for Prof. Karl Pearson in his graphical courses in applied mathematics and mechanics.—An interview with Mr. James Clifton Robinson, A.I.C.E., A.M.I.E.E., the managing director of the London United Tramways Company, Limited, has appeared in the columns of the *West London News*.

The Apprentices' Institution.—The cause of technical education has in recent years been advocated on every platform as one on which the industrial and commercial welfare of the country in large measure depends. But it has been felt in the best-informed quarters, says the *Times*, that technical schools in the ordinary sense cannot meet all the requirements of the case. A boy or girl must first choose a trade, and then acquire the technical training suitable to that trade, as technical teaching at large would only lead to the proverbially dangerous smattering. There is, it is true, a superabundance of labour of all kinds seeking employment, but of really skilled artisans in the numerous trades which are not yet appreciably affected by machinery there is a scarcity rather than an over-supply, and there are some which are almost monopolised by foreigners. As a remedy for this state of things, and as a contribution towards the solution of the problem of the unemployed, it is proposed to establish an institution for the organisation and encouragement of the apprenticeship of boys and girls on leaving school. The scheme, of which Mr. J. Ballin is the secretary and one of the principal promoters, has met with the approval of a great number of eminent and experienced men, including Lord Rothschild, Sir John Lubbock, Sir S. Montagu, Sir J. Blundell Maple, Sir George Williams, Mr. Quintin Hogg, the Hon. W. N. Bruce, Sir Stuart Knill, Sir Richmond Cotton, Dr. Garnett, and the clerks to the Drapers', Mercers', Turners', Goldsmiths', Stationers', and other companies; and it is proposed to appoint a committee comprising a number of gentlemen with special and general knowledge of the subject. The institution will keep a register of employers and of applicants for apprenticeship. Preference will naturally be given to those trades which require the greatest skill and the teaching of which will take the longest time. Loans and grants of money will be made for the payment of premiums and the purchase of tools, and it is calculated that about £15 will suffice for each boy and £5 for each girl. Every precaution will be taken to prevent pauperisation, and in most cases the apprentice will be required to repay the advance by small weekly instalments out of his wages, though in cases of hardship in which it is specially difficult for parents to dispense with the earnings of their children, the conditions will be relaxed. It is anticipated that connection with a great institution such as it is hoped to establish, will have a steadying and elevating effect upon the young men and women whom it has benefited, and in furtherance of the scheme clubs will be established or assisted in suitable localities. The institution will also encourage the attendance of its *protégés* at evening classes for technical instruction, and make grants or loans for the payment of fees. One effect of the scheme will probably be to raise the standard of work and to increase the prosperity of masters in a comparatively small way of business; but by careful choice both of apprentices and masters, and the consequent provision of good training, it is hoped to provide the largest employers on the shortest notice with artisans on whom they can thoroughly depend, and certificates of efficiency will be awarded which will serve as an avenue to employment.

Conference on Technical Education.—A conference of representatives of technical instruction committees of county councils and of others interested in technical education was held on Thursday last week at the Society of Arts, John-street, Adelphi, for the purpose of affording an opportunity for the discussion of measures which the society have in view to enlarge the scope of their present action in the matter of examinations. According to a statement issued by the council of the society, there is a lack of a central organisation which might deal especially with such questions as the examination and inspection of classes. "In spite of the valuable work which has been done by the City and Guilds of London Institute, and by other bodies, it is only in a portion of the subjects sanctioned as subjects of technical instruction that examinations are held. The wide field of agriculture and home industries is untouched, while no means are provided for anything like a general system of inspection which local authorities may call to their aid should they desire to do so." Major-General Sir John Donnelly, chairman of the council of the Society of Arts, presided, and there were present Mr. W. Bousfield and Mr. Palmer, representing the City and Guilds of London Institute; Mrs. Maitland, Mr. Sinclair, and Mr. Laing, members of the London School Board; Mr. Snape, M.P., chairman of the Technical Instruction Committee of the Lancashire County Council, and a large number of prominent representatives of similar committees in other counties. The Chairman, in opening the proceedings, referred to the valuable work done by the Society of Arts in past years in initiating educational movements.

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Among other things, the society established the technological examinations which were taken over by the City and Guilds of London Institute; and he wished to make it clear that the council of the society did not desire in any way to interfere with the examinations of the City and Guilds of London or any other similar body. There was a wide range of subjects, however, which other bodies had not yet touched; and it had been suggested that it was desirable to include these subjects in their system of examination. This would enable students to secure certificates, and technical inspectors would be provided to assist local councils in ascertaining whether their classes were being conducted on the right lines. His idea was that they should endeavour to establish a joint examining and inspecting Board formed of representatives of the present examining bodies and other authorities; but they had not yet got as far as that, and the object of the Society of Arts now was to ascertain the wishes and opinions of those who were interested in the matter. In order to open the discussion, he moved: "That it is desirable that the Society of Arts should extend its system of examinations, and provide for examination and inspection in those subjects which are not taken up by other bodies." Ultimately Mr. Reynolds, of Manchester, moved as an amendment: "That in the opinion of this meeting it is desirable that provision should be made for examination and inspection in the subjects of instruction undertaken by technical instruction committees but not at present included in the schemes of the Science and Art Department, the City and Guilds of London Institute, and the Society of Arts, and that with the object of giving effect to the same this conference recommends that a representative committee be appointed to draw up a report and prepare recommendations on the whole subject." Mr. Hodgson (Cumberland) seconded the amendment, and after some discussion it was agreed to and adopted as the substantive resolution. The proceedings then terminated.

A Submarine Post.—Mr. J. Henniker Heaton, M.P., in the *North American Review* says: "Two generations ago a heaven-sent genius took pity on the two great sister-nations of the Anglo-Saxon stock, dwelling isolated and apart, for ever sundered by the wild, tempestuous ocean. A slender wire was laid across the depths of the watery abyss, and an end of this wire was placed in the hand of either sister. 'Now speak,' said their benefactor, 'as if you were face to face. Share your joys, sympathise with each other's sorrows; take sweet counsel together; and if, as is the wont of your sex, you talk overmuch and overlong, why, you will be all the better friends." Why is it that this delightful vision has never been realised? If a man with a business of moderate dimensions corresponds with London customers by letter, knowing that his wealthy rivals habitually employ the cable for the same purpose, it is not because he prefers a week's delay, but because he cannot help himself. On the other hand, capitalists would be glad to have the rate 5dol. a word, in order to kill the competition of poorer men. Yet even rich men writhe a little in the grip of the cable companies; and this is why 97 per cent. of the messages are sent in code. The proportion of social messages exchanged between relatives and friends on matters of private concern—only 3 per cent.—is so small as to be hardly worth taking into account at all. The Atlantic cables are controlled by a monopoly; that is the evil to be dealt with. Strictly speaking, it is a duopoly, for there are two groups of shareholders interested; but these two maintain a common tariff, and so far as the public is concerned, all the evils of a monopoly exist. Unless competition be independent and unrestricted, its wholesome influence is non-existent. Let me here say, once for all, that I do not presume to censure the sagacious and energetic men of business who have laid the cables, and now work them. Some of these gentlemen—I refer, above all, to my friend Sir John Pender—have displayed financial and administrative talents of the highest order; and they cannot be blamed for monopolising electricity any more than others can be blamed for monopolising gas and water. The true culprits are the British and American Governments, which have allowed private persons to undertake State responsibilities and to intercept benefits that belong to the public at large. The communications of the people ought not to be at the mercy of a calculating director, who will naturally prefer a small number of messages at a high rate to a larger number at a lower rate. For such reasons the postal service in every civilised country is managed by State officials. But in every country the telegraph is superseding the post. The mere fact that an inland transaction can be arranged by telegraph or telephone in an hour, at any distance, as against 24 hours by post, causes a corresponding reduction in the time required for carrying out the bargain. Where, as in the case of Anglo American trade, the arrangement by post takes a fortnight, it is obvious that the bulk of such trade being conducted by post is handicapped with a fortnight's delay. The number of words sent over the cables between America and England last year was 23,000,000. Of these 20,000,000 were business messages at 1s. per word, and the balance, 3,000,000, were messages at 5d. per word. Deducting some small charges, the total income from Anglo-American cables may be put down at £1,000,000. Now, by means of the recent improvements, 45 words per minute can be sent over one wire, so that the 12 cables might be employed to send in one year no less than 283,824,000 words? It must be remembered, however, that only two of the 12 cables are extensively employed. Indeed, a cable expert of high authority is of opinion that the new cable of the Anglo-American Company, having a weight of 400lb. of copper to the mile, is of sufficient capacity to carry all the existing traffic. The cost of laying a Transatlantic cable is said to be about £500,000. If so, the total cost for the 12 working cables, and three which have been abandoned, is about £7,500,000. Yet the capital of a single company is £7,000,000, while for £1,000,000 we might at once lay two cables capable of doing all the work. The interest on £1,000,000 could not exceed £50,000, and the working expenses would be about £80,000; total, £130,000. For which annual expenditure the public might have a service just as good as the present one, for which it pays the companies £1,000,000. What I propose is that the British and American Governments should jointly acquire the property and rights of the existing cable companies at a fair valuation, and establish a common State monopoly in cable communication. They should then establish a tariff of 1d. per word; and the result would be a prodigious development of trade and an immense increase in the happiness of the masses. It is by no means impossible that ultimately the tariff might be still further lowered—down, in fact, to the lowest remunerative point. For governments have no right to make a profit out of the communications of the people. This programme is by no means a visionary one. For no appreciable increase of expenditure accompanies the augmentation of the traffic over a wire, which is almost pure profit. If the traffic increased twelve times under a penny tariff, the revenue would be the same as at present; but the State would be satisfied with less than half the revenue of the companies. In fact, it would be perfectly feasible to telegraph the whole of the letters now exchanged between the two countries for the sum which is now paid to the mail steamship companies."

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ROTARY-CURRENT AND ALTERNATING-CURRENT DYNAMOS OF THE ALLGEMEINE ELECTRICITATS-GESELLSCHAFT.*

BY M. VON DOLIVO-DOBROWOLSKY.

The relatively large number of poles in alternating-current machines which were necessary to reach a high number of alternations at a small number of revolutions, rendered an economical design of the field magnets most difficult. A certain saving was, however, effected by using one field winding to do the whole work, instead of exciting each pole separately. The first alternator of this kind was probably that of Klimenko, of Charkow, which was exhibited

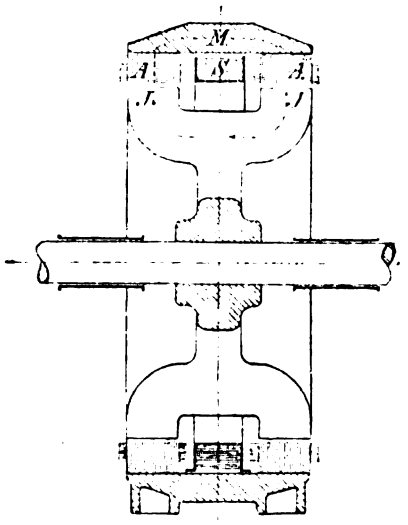

FIG. 1.

at the Vienna Exhibition of 1883. The bad proportioning in the design of this machine prevented it from coming into a more general use. The Mordey alternator of the latter end of the eighties, which is really derived from the Klimenko machine, was, in fact, the first practically useful machine with a single-coil magnet. To-day there are many modifications of this type of machine in existence, as, for instance, the one built by the Machinenfabrik Oerlikon with Brown's inductor and several others. One might predict that the single-coil magnet arrangement will come to the front in the construction of alternators in the same

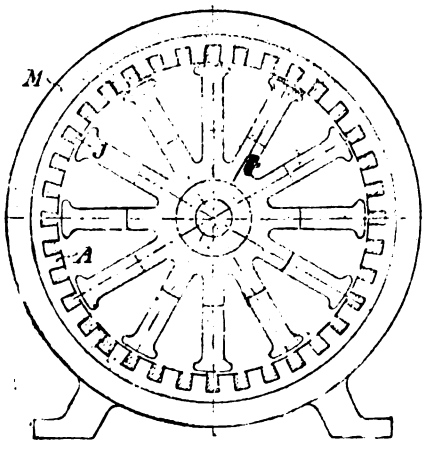

FIG. 2.

way as the ring-pole arrangement with radial magnets has, in the case of continuous-current dynamos, displaced all previous forms of magnets. Besides its main advantage, economical excitation, the exciting coil of a single-coil magnet in some of its forms may be made stationary, so that only the magnet core with its poles revolves. The 1883 machine of Klimenko was without any revolving wires. On the Mordey alternator the magnet coil could also be made stationary; the reason for not doing this in practice lies entirely in the mechanical difficulty of securing the relatively heavy coil to the light disc armature in a workmanlike way. After this introduction, I come to the description of two types of alternators built by the Allgemeine Elektricitäts-Gesellschaft, of Berlin.

Both types belong to the single-coil magnet class with stationary winding. The first kind, shown in Figs. 1 and 2, is most suitable for high speeds, consequently for belt or rope driving. From both illustrations it will be seen that the magnetic circuit is completed by the outer case, M, the two armature rings, A, which are built up of laminated iron, and the tooth-wheel or turbine-wheel inductor, J, which latter is shown separately in Fig. 3; S is the exciting coil and is fixed to the frame, M. The pole-pieces of the inductor wheel give rise on the inner face of the armature rings to points of very uneven distribution of field, so that by rotating the inductor the armature coils, which are to be seen in Fig. 2, receive an induction through the number of lines of force which flow in them being changed. On the outer face of the armature, A, the distribution of field is homogeneous, and therefore nothing prevents the lines of force being led through the frame, M. Here I will remark at once that similar machines have been built by Stanley in America, and by Sollman, of Wahl and Co., in Russia. A

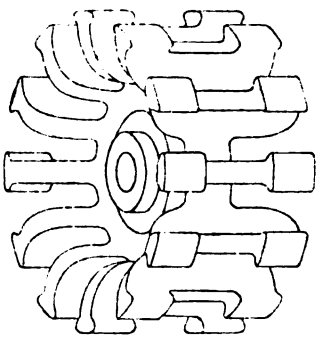

FIG. 3.

number of alternators of this type has been designed, some also with the modifications as shown in Fig. 4. A 100-h.p. "drehstrom" generator of this type is now at work at the sugar refinery of Messrs. Schwengers Söhne, at Uerdingen, on the Rhine. Of course this kind of machine is suitable for either single-phase, multiphase, or "drehstrom" current. In Fig. 2 the number of armature coils is three times as large as the number of pole-pieces, whereby three currents of 120deg. phase difference are produced. Instead of the pole-like arrangement of the armature winding, the opposite coils can be connected, which is admissible for machines of low voltages, and sometimes even an advantage. In larger size machines the bar winding can be used, as shown in Fig. 5, where each of the coils consists of only one copper bar. Three machines of this type, of 300 h.p. each, are at present under construction at the works.

Besides this type of machine, which is, as stated before, more to be recommended for the high speed, we are also building a slow-speed machine of a smaller width, but greater diameter, suitable for direct driving. The same is also on the Klimenko principle. Figs. 6 and 7 show clearly that the magnetic lines generated in the large exciter coil, S,

FIG. 4.

run evenly through the iron ring, M, and the two armature rings, A, when the magnetic circuit is closed by pole-pieces, P. When these pole-pieces, which are fixed to the flywheel of the engine, rotate, points of high magnetic density evidently travel along the surface of the two armatures, and the armature coils, which are clearly shown in Fig. 6, receive an induction. Things can, of course, be also arranged for multiphase currents by simply using a proper number of coils relatively to the poles. Rotary-current dynamos of this class are at present being built for the electric supply station at Strassburg—viz., three of 400 h.p. and two of 200 h.p. each.

Besides the advantage of having no collecting brushes, the

* Paper read before the Elektrotechnischer Vorein, Berlin.

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little attention which these machines require, the simple and strong construction, is at once evident even from the illustrations. It is impossible to touch the high-pressure coils when the machine is running, as the revolving flywheel in front of it prevents this. When repairing the whole frame can be moved back, and the armature winding becomes easily accessible. As to the electrical advantages of this type of machine, two must be specially mentioned—first, the economic excitation; secondly, the very small drop of potential. Some consideration should also be given to the naturally small hysteresis, which, in combination with the little exciting

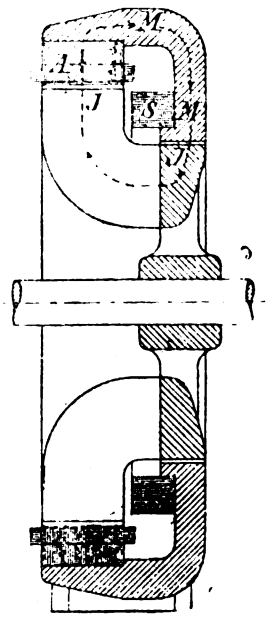

Fig. 5.

current required, enables an especially high efficiency to be obtained even at light loads. To demonstrate these advantages by data, I will give you the principal figures of the 400-h.p. machine for the Strassburg station: output, 280 kilowatts at 2,750 volts; revolutions, 150 per minute; number of poles, 40; weight of copper of magnet coil, 730 kilogrammes; weight of copper of both armatures, 200

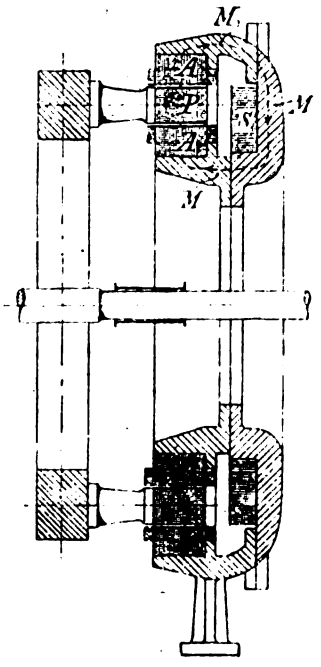

Fig. 6.

kilogrammes; excitation required, 4,000 watts—about 1·4 per cent.; total watts consumed in both armatures = 2 per cent.; total hysteresis loss about 1·3 per cent. This machine requires, in spite of the small loss, only a little over two kilogrammes of copper per horse-power. The ratio of the effective ampere-turns of one armature coil to the ampere-turns of the exciter coil is about 1·15.

That the weight of iron is not in consequence very high the following figures will show:

Frame	6,000 kg.
Both armatures	2,000 ,,
Pole-pieces	750 ,,
Total weight of iron exclusive of shaft and bearings...	8,750 ,,

Before I conclude, I would like to refer once more to the discussion of last meeting on the most suitable fall of potential in alternating-current dynamos. As is known, Hopkinson in the eighties found by calculations that for the synchronous running of two alternators a certain ratio between resistance and self-induction was most suitable, and that the self-induction had the most important *rôle*. From this many concluded that plenty of self-induction must be provided, as it is nearly impossible to calculate the Hopkinson ratio in advance. But often the machines got too much of it, and the consequence was they would get out of step. This was explained by saying there was still not enough induction, and we eventually tried to bring the machine to such a point that by means of self-induction it could not give more than 1½ times its normal output. Mordey at the end of the eighties maintained just the contrary—*i.e.*, that alternators should have little resistance and little self-induction. The smaller the fall of potential of the machine the easier large currents could be got out of it. However, the most practical and demonstrative proofs of Mordey could not at once shake the general belief in self-induction, and the dispute is still unsettled to-day. Of course, after the many experiments with alternators with a small fall of

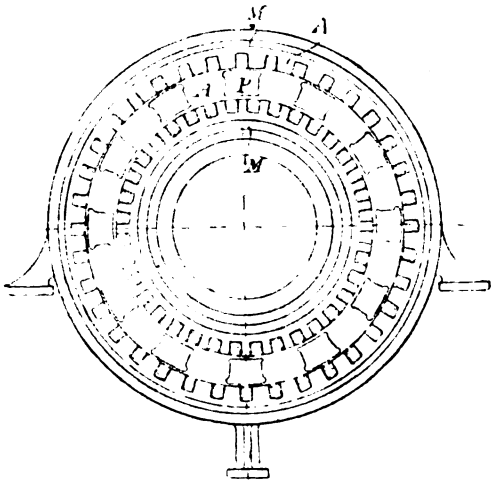

Fig. 7.

potential, which have been proved to run just as good in parallel as alternators with a large one, certain theorists have moderated their demand, and, in fact, are already satisfied with a fall of potential of from 15 to 20 per cent. I think one can predict that dynamo constructors will soon come to the general opinion that a little fall of potential more or less is of no consequence to good parallel running, especially as there are no practical proofs that too little resistance or self-induction has ever prevented alternators running in parallel satisfactorily. When, however, neither parallel running nor the conditions of synchronism require a large fall of potential, the most important argument for building alternators with self-induction disappears. The fall of potential has many disadvantages which are specially felt in motor driving. The wattless current component operates with its full ampere-turns in the direction of the magneto-motive force of the primary machine; therefore with motor currents one has a bigger reduction of the magnetic field than with lighting currents, and a machine of the latter class with a fall of potential of 15 per cent. is therefore not suitable for satisfactory motor work. If we consider that small motors seldom have cos ϕ more than 0·7 and large ones scarcely above 0·87, and, on the other hand, figure to ourselves that the wattless component amounts to from 0·7 to 0·5 of the whole current, we can easily perceive what a detrimental result the above-mentioned subtraction of ampere-turns must have. As, however, at the present time the motor question requires the greatest

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consideration on the part of electric supply stations, doubtless the question of dynamo design will be answered in one way only—that is, to have the smallest possible fall of potential. No lowest limit can be fixed to this, as even the best of existing machines are far from being perfect in this direction. In my opinion, and according to my experience, it is entirely necessary and quite possible that the fall of potential due to the lighting current should not exceed 4 to 5 per cent., as even then we have still at full load with motor current a fall of from 15 to 20 per cent. The only intelligible reason which was brought forward against such machines is the danger of short-circuiting. Experience with continuous currents has taught us, however, that the dynamos are better protected by good fuses and automatic cut-outs than by a counter-compound winding. Therefore with alternating-current—rotary current work—we can very well do without the self-induction, which otherwise only deteriorates the machine.

In conclusion, I should like to remark that in the last part of my paper I have treated the self-induction and armature reaction to a certain extent as one, which is not quite correct. However, it was rather an explanation of the self-induction itself I wished to give you to-day than its origin and calculation. Besides, both phenomena are very nearly related and generally appear together, and are of the same order, so that machines with much reaction have likewise large self-induction, and *vice versâ*.

THE BLONDEL LUMEN-METER.

This is an apparatus for the direct determination of the mean spherical intensity of a source of light. M. A. Blondel has designed this new method of measuring more quickly and accurately than by any previous attempt mean spherical candle-powers with a view to overcoming the old laborious methods, which were complicated and uncertain. He encloses the source of light to be measured in the centre of a sphere, Fig. 1, carefully blackened inside,

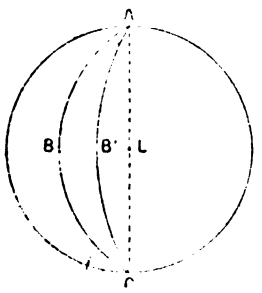

Fig. 1.

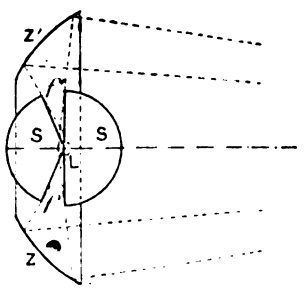

Fig. 3.

and having one or more openings of the segment shape shown in the figure. The rays of light which come out from one of the openings, A B C B', of a solid angle, α, is a determinate part of the total light emitted. If the source of light is symmetrical all round the axis A C, it is sufficient to measure the light emitted by the aperture, and to multiply it by $\frac{\alpha}{2\pi}$ to get the value of the total flux, Φ, then the mean spherical intensity, I_m, can be obtained, as

$$I_m = \frac{\Phi}{4\pi}.$$

If the light is not symmetrical, and the angle α is $\frac{1}{n}$ of 2π, then it is necessary to measure the light when the aperture is in n different positions round the light. If, instead of the spherical candle-power, the light passing to the lower hemisphere only is wanted, the aperture must be shaded on the upper side of the horizontal plane passing through the light.

Such is the general principle of the new method which has recently been devised and put in working order by M. Blondel. In order to measure the light passing through the segmental opening, its effect is concentrated by a projector, M, on to a diffuser screen, G (Fig. 2), which will disperse the light by transmission or reflection. Care must be taken that the system of reflectors shall cause all the rays of light to fall on the screen almost normally (the admissible error in direction may rise to 40 per cent. for certain diffusers, such as opal glass, but must not exceed a few per cent. if a paper screen is used). The photometer, P, is placed opposite the screen in such a way that it receives the diffused rays only, and at such a distance from it that the angles made with the rays of light on the photometer surface are sensibly the same for all parts of the luminous screen. The other face of the photometer is lighted by the standard light, I^1. As the positions of the projector, the screen, and the photometer are fixed, the standard lamps have to be moved to get a determination. It can be easily shown that the lighting effect produced in the photometer, P, by the illuminated screen, g, is proportionate to the light emitted from the aperture; or, in other words,

$$E = A\,\Phi,$$

A being a constant depending on the joint effects of the coefficient of reflection of the projector, the coefficient of diffusion of the screen and the distance, l, between that screen and the photometer. In displacing the standard, I^1, to a distance l^1 will give an equal light on the two faces of the photometer, one gets that—

$$\frac{I^1}{l^2} = A\,\Phi.$$

From which Φ is obtained when the constant A has been determined from preliminary experiments with the apparatus.

For the projector, M. Blondel uses preferably an elliptical or parabolic mirror. By limiting the active part to a vertical plane through the focus, as is shown in Fig. 2, the light emitted to a hemisphere can be collected. Two measurements then suffice to measure the total flux. But the angle of incidence of the rays on the glass then varies within wide limits, and it follows that there are from 5 to 6 per cent. variations in the reflecting power at different points of the projector. The constant A is therefore bound to be inaccurate. So M. Blondel, after having tried many ways of solving this difficulty, prefers for accurate work to limit the apertures to two small symmetrical

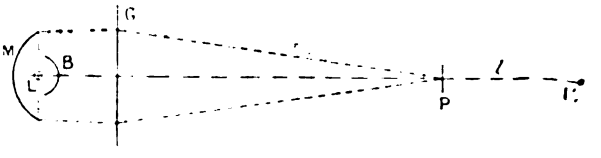

Fig. 2.

segments of about 18deg., Fig. 3, thus keeping down the variation in the angle of incidence. In this case the variation of reflecting power does not reach 1 per cent., and the mirror can be reduced to an elliptical zone of revolution made to reduce to a minimum the dimensions of the lighting portion of the screen. This screen is placed about 10ft. from the mirror, and the space between it and the photometer is about the same. The zonal lumenmeter, which has been manufactured by Messrs. Sautter, Harlé, and Co. at their own expense, is represented diagrammatically by Fig. 3 and in perspective by Fig. 4. An opening is left at the top for the arc lamp to be admitted into the sphere, which is made in one with the reflector. For gas and other lamps the apparatus can be inverted by turning it round the pivots (seen in Fig. 4), so that the opening comes at the bottom. To assist in the introduction of the lamps a portion of one hemi sphere can be removed, as it is only held in position by two buttons. It will be noticed that the apparatus is so arranged that no stray rays can escape.

With a view to facilitate the employment of his method in laboratories, M. Blondel has designed a more simple but less accurate apparatus manufactured by the same firm. In this design the zone of silvered mirror is replaced by a conical zone of a white diffusing material much less costly. The diffusing screen is then dispensed with, and the photometer is placed on the axis of the cone at as great a distance from it as possible compared with its dimensions. The emitting power of the cone being proportional to the light,

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if the diffuser is well chosen (M. Blondel advises a matt enamelled surface, easily obtained), it can be proved that the light thrown on the photometer, fixed sufficiently far away, is proportional to the flux of light to be measured. It is a good plan, in order to avoid the errors resulting from reflection from the diffuser on itself, to use in this case only one segment instead of two. This new apparatus described above, called by its inventor a "lumen-meter," seems likely to be of great use in photometry. It gives a ready means of ascertaining the light-giving properties of various sources of light.

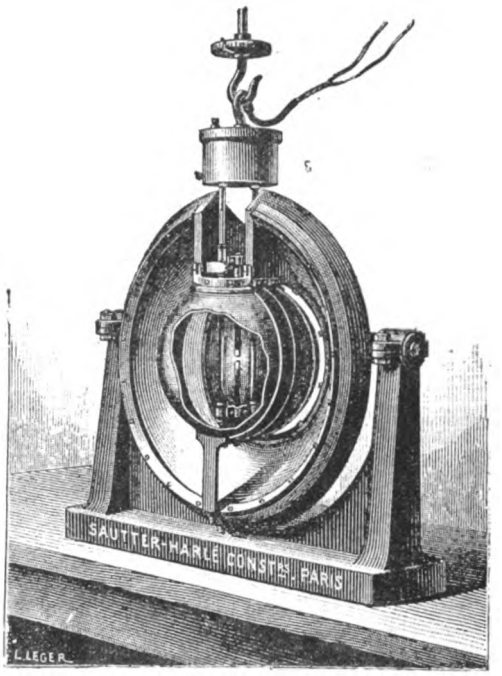

FIG. 4.

We cannot better illustrate the practical use of the apparatus than by citing an experiment made with it by M. J. Rey. The reflecting zone type was used, and he presented the results obtained to the Société des Electriciens during the last session. M. Rey has compared the light emitted by an arc using the same power with two different sets of carbons, with the object of showing the influence of the diameter of carbons on the lighting efficiency. He found the following values:

Current in amperes.	Volts.	Diameter of carbons, in millimetres.			
		+ 21	− 13	+ 14	− 9
		Φ in lumens.		Φ in lumens.	
20	44	7.900		21,330	
25	44	9,430		33,830	
30	45	16,260		46,330	
35	46	28,100		61,330	

The lumen is the unit adopted by M. Blondel in this system of measurements. It is equal to the light emitted from a source having an intensity of one decimal bougie in a solid angle equal to units. The figures of the table divided by 4π give the mean intensities in decimal bougies. The results show that the light emitted is threefold, due to the change in the carbons. One cannot therefore attach too much importance to the judicious selection of the size of carbons, and to the practical means which permit such comparisons to be easily ascertained.

ELECTRIC LIGHTING OF TRAINS.—V.

BY R. W. WEEKES, WHIT.SCH., A.M I.C.E.

(Concluded from page 652.)

I have now described the apparatus used for train-lighting on the three railways on which it has been extensively employed. On other lines isolated trains have been lighted electrically; and on others, again, attempt are now being made to introduce new systems. On the London and Tilbury Railway, electric lighting gear which is stated to fulfil every reasonable requirement is being tried. The inventors of this apparatus do not consider that their apparatus is yet sufficiently perfected to be described. They have followed on the lines laid down by Mr. Langdon as being required for an ideal system, and have lighted every carriage independently. Each coach thus contains its own dynamo and accumulators. The train can be uncoupled at any part, or any single carriage can be attached to a train which is lighted by either oil or gas. It will be interesting to learn if this apparatus is sufficiently simple to keep both the first cost and cost of upkeep within reasonable limits.

There is yet one system of electric lighting, largely used on the District and Metropolitan Railways, to be described, although the light supplied by it has to be paid for by the public. This is the automatic penny-in-the-slot lamp installed by the Railway Automatic Electric Light Syndicate. These lamps, which are illustrated by the following figures, have been devised by Messrs. Davies and Tourtel to supply the public with a convenient reading lamp. The lamps are placed in the four corners of the compartment in such a position that the light is projected over the shoulder of the traveller and concentrated on to his book or newspaper. Each compartment has its own accumulators for supplying the light, but it has been found advantageous to connect all the carriages in parallel. When this is done, an accident to one set of accumulators, such as the breaking of a lug, does not cause failure of light. The functions of the lamp are as follows: on the passenger placing his coin in the slot he releases the switch, and on this being pressed home he receives light for half an hour which enables him to read with comfort. The next feature is the honesty of the apparatus; should the lamp be faulty, or the battery connection broken, the coin is returned forthwith.

The batteries are taken to be charged to the company's headquarters at Mill Hill Park, Acton. The outfit of this charging station was described in the *Electrical Engineer*, vol. xiii., page 137. Six special trucks were designed by the engineer for conveying these batteries. The general arrangement will be understood from Figs. 29 and 30. Fig. 29 shows the elevation partly in section. Each truck is capable of taking four rows of seven boxes of accumulators, each box containing six cells. The boxes in each row are connected up in series, so that a charging voltage of about 105 volts can be used. The charging shed or siding will take three trucks at a time. Mr. Tourtel, who has complete supervision of the whole plant, makes it a rule that every box of accumulators shall be recharged at least once a week, even in summer, when the demand for light is not so great. In this way the accumulators receive regular attention, and their life is correspondingly increased. I am unable to obtain figures as to the actual cost of maintenance, but the present staff, both on the line and at the charging station, would be able to handle successfully a much larger number of trains so lighted. The company have fixed their lamps in carriages which are also well lighted by gas, but I should expect these automatic lamps to have a much larger support on those local lines round London which still use oil lamps in their suburban trains.

The mechanism by which the lamp is automatically worked when the coil is inserted is shown in Figs. 31, 32, and 33. On being inserted, the coin falls into the pocket, C. This pocket also acts as the arm of the switch, but the plunger, A, does not engage with it unless there is a coin in the pocket. When A is pushed back, an armature, E, is brought up to the magnets, H H, which holds it back when the current passes. Should the apparatus not be in working order, the armature and coin pocket move back as the plunger is released, and the coin is returned down the shoot, R. Otherwise, if the current passes the coin falls to the bottom of the box.

The act of pushing back the plunger, A, also winds up the clockwork by means of the circular rack, J, and closes the circuit through the switch, J_1. A projection, *a*, on the plunger engages with the lever, N, and starts the balance-wheel of the clock. The clockwork is designed to run for half an hour, during which time the rack, J, is

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slowly resuming its original position. Finally, the rack breaks contact with the spring, J_1; the magnet thus loses its power, and the spring, V, brings the coin pocket back into the position shown in the diagram, Fig. 31.

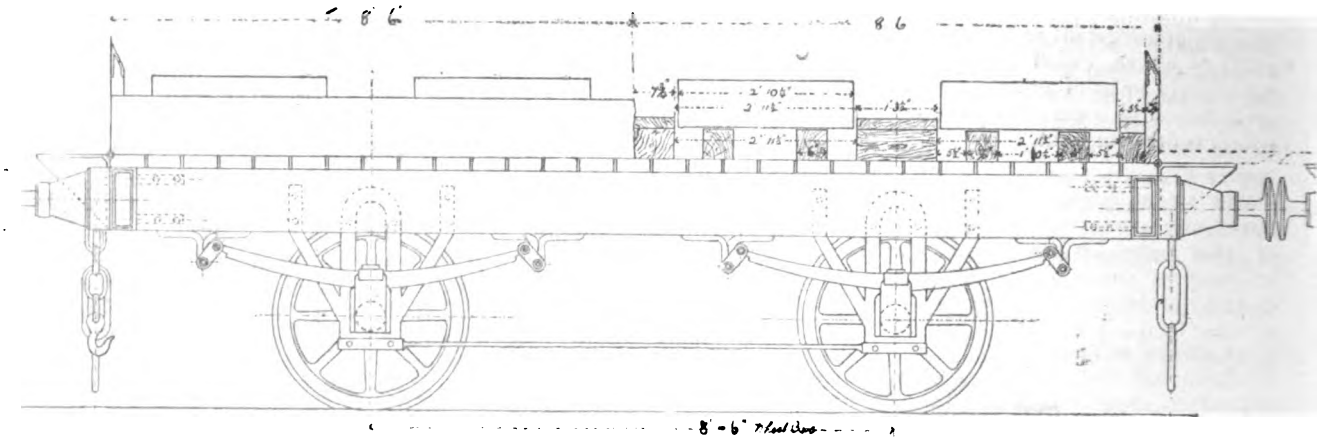

FIG 29

Should the passenger be leaving the train before the expiration of the half-hour, he can extinguish the light by pressing the small plunger, P. This plunger engages with the slide, P_1, and breaks contact by removing the spring, G, from its normal position. The small incandescent lamp is placed in a socket-holder insulated from the case. The reflector, *y*, is attached by two screws, *b*, b_1, worked in circular slots, *c*, c_1, to the main casting. The parabolic lens, Z, can thus be turned round the axis of the lamp, so as to project the light at the required angle. In this way the light is available to eight persons in the carriage—*i.e.*, those occupying the corner seats and those adjacent to them. A special board is fixed to the carriage as a support for the lamp, and it contains three contact springs—two being for the lamp supply, and the remaining one on an alarm circuit. This is arranged to ring a bell in the guard's van should the lamp be forced open by the enquiring public. There is, however, no excuse for this rough treatment on the ground that the apparatus receives the penny when out of order, as is the case in some automatic machines.

The Cost of Electric Train-Lighting.—Very few figures are available as to the actual cost of electrically lighting trains in England. On the London and Brighton and South Coast Railway, where some 40 trains are so lighted, the annual cost per train is stated by Mr. E. J. Houghton to be £54. In this item no charge is made for extra cost of

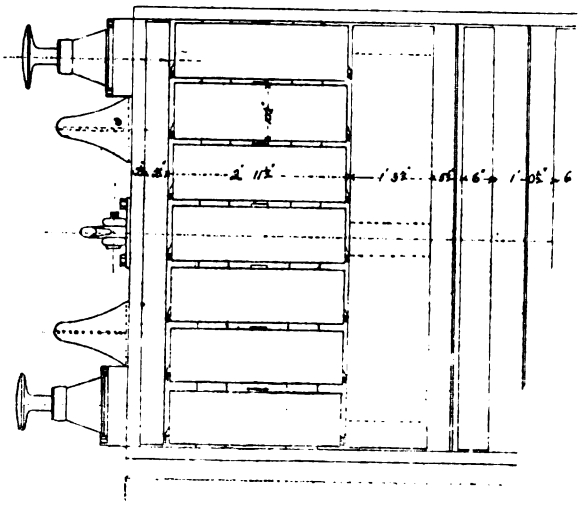

FIG. 30.

coal on the locomotive due to the power absorbed by the dynamo. As no allowance for this is made to the engine driver in his coal supply, I conclude that the quantity is small. On the Great Northern Railway, where a somewhat similar arrangement is used, the annual cost per train is given as £150. The apparent great difference between these two figures can be explained to some extent by the fact that the Great Northern have fewer trains lighted electrically, and that the candle-power per train is greater. The whole point hinges chiefly on the question of cost of supervision, and it will be readily understood that this cost decreases rapidly as the number of trains lighted increases. Even assuming that the £150 per annum is the present cost on the Great Northern Railway trains, it follows from the figures furnished me by Mr. Ireland that the average cost per unit throughout the year is only 7¼d.

It is also difficult when the head official in charge of the electric lighting of the train has many other important

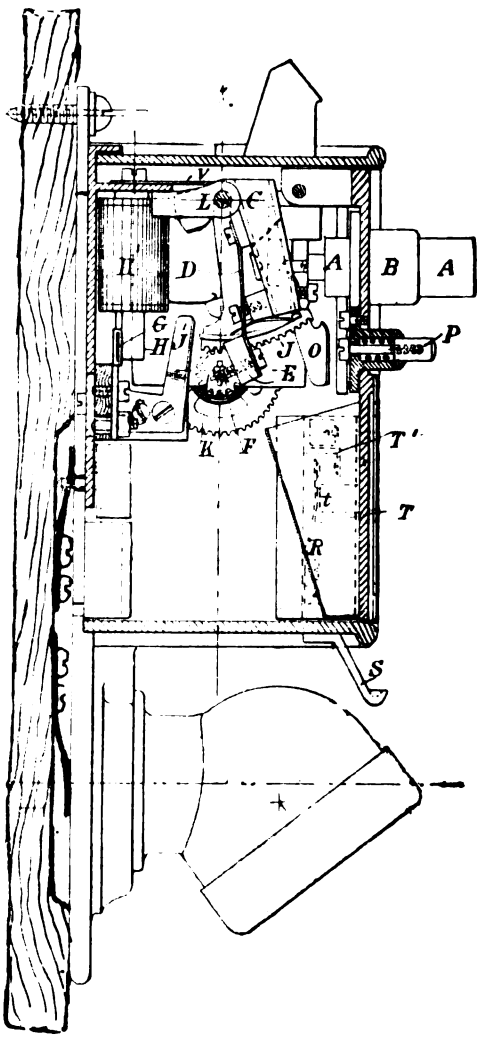

FIG. 31

duties to perform to correctly divide his remuneration over the various departments. This may also account for the discrepancy between the two figures given above. I am assured by three engineers in charge of three of the largest lighting schemes that the average life of the accumulator used for railway work ranges from 2½ to 3½ years. It will be thus seen that the upkeep of accumu-

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lators forms one of the largest items in the annual cost of the various train-lighting systems used in England.

Besides the cost of renewing, say, one-third of the batteries each year, there is the cost of examination and nursing of sick batteries.

The question naturally arising is, Are we obliged to use accumulators so largely for train-lighting? Their use is necessitated from the present universal method of driving the dynamo from the axle of the carriage. The variation of speed, and at times the cessation of generating power, forces the engineer to use storage batteries. It also requires that a larger dynamo shall be employed, as the whole of the power required for lighting has to be generated and partly stored during the time that the speed of the train exceeds certain limits. Again, a large amount of automatic machinery is required with this method of driving to ensure even fairly constant pressure at the lamps. While recognising the advantage of this method of driving in some respects, its absurdity in others

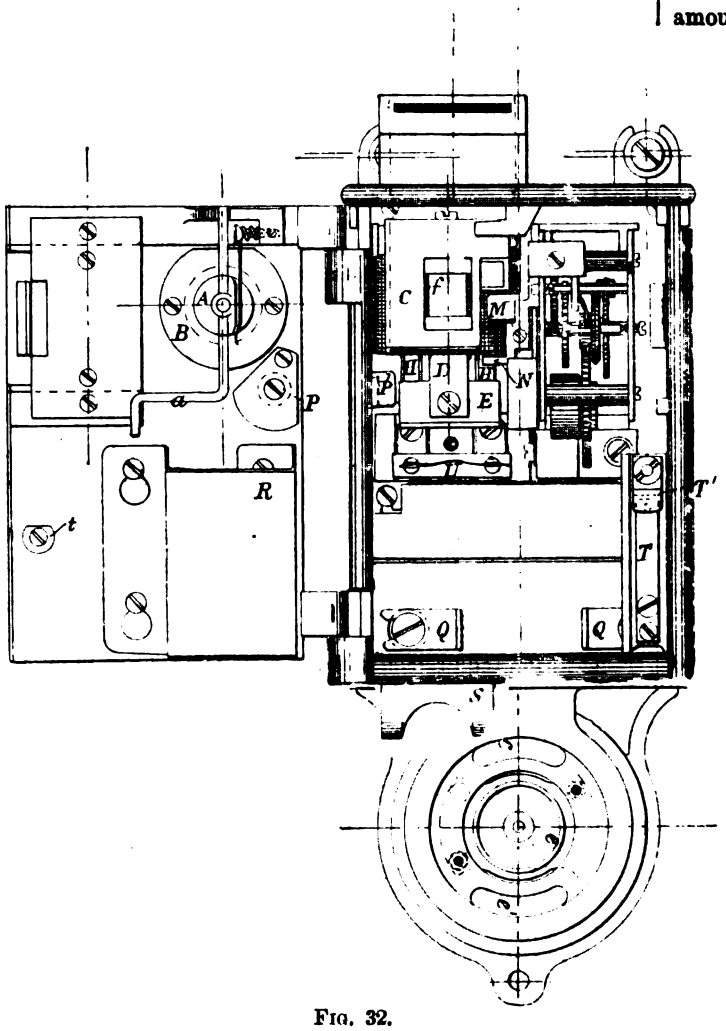

FIG. 32.

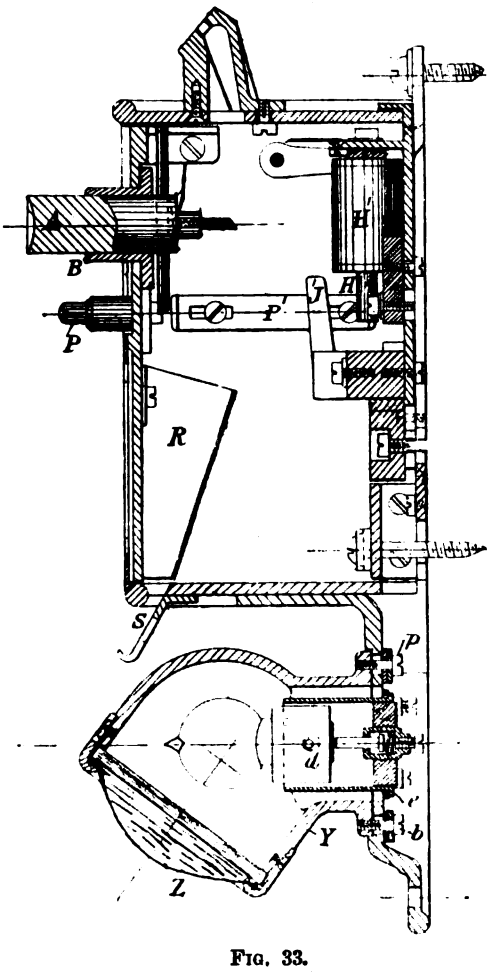

FIG. 33.

can be seen from a parallel arrangement for electric lighting of steamships. No engineer has, I believe, yet proposed to drive the electric lighting machinery on a steamer by means of a paddle-wheel caused to revolve by the passage of a ship through the water.

Instead of this, the available boiler pressure is used to drive special electric lighting engines at constant speed, and I believe that the same system would be found both cheapest and best for railway lighting. The first cost of plant would be considerably reduced. The automatic gears now so largely used would be dispensed with, and batteries of small capacity would only be required on the long express routes to supply the light while the engines are being changed. This system of lighting was tried on the Great Eastern many years ago, but given up on account of the uneconomical engine employed for driving the dynamo. The dynamo and engine for driving it should be placed on the engine, unless at first it is better to have it in the guard's van, and steam supplied to the engine by a flexible steam-pipe. The engine driver in either case could give the plant sufficient attention if efficient oiling arrangements are adopted and good governing gear.

Some figures as to the cost of electric lighting of trains in America were given by Mr. W. B. Leonard in a paper read last year before the American Society of Railway Telegraphists. These figures, owing to the short time most of the systems have been at work, are not to be depended on to any great exactness, but are interesting. The first cost of various systems of lighting trains by electricity, and also of the annual expenses of working, the light is appended. The figures are given for the five following different electric systems, and compared with those for oil and gas.

(*a*) Lighting direct from a dynamo, as arranged by Mr. G. Gibb, engineer to the Chicago, Milwaukee, and St. Paul Railway. In this case a 15-kilowatt dynamo is coupled to an 18-h.p. Westinghouse engine placed in the luggage van and supplied with steam from the locomotive boiler. In winter the boiler which is used to heat the train supplies this engine as well. The number of 16-c.p. lamps per train amounts to 225 in some cases.

(*b*) Lighting by dynamos with accumulators in each carriage, as used by the Pullman Company.

(*c*) Lighting by accumulators only, as used by the Pullman Company.

(*d*) Lighting by accumulators only, as on the Chesapeake and Ohio Railway.

(*e*) Lighting certain carriages by dynamos driven from the axles and using accumulators in the intermediate carriages, on the Lewis system.

(*f*) Lighting with Pintsch gas, with burners 6 c.p.

(*g*) Lighting by oil with a duplex burner giving about 2 c.p.

In all the electric systems 16-c.p. lamps were used. Mr. W. B. Leonard has assumed that the light is used each day for 10 hours, and has based his figures for the daily cost on this uniform assumption. He points out that the Gibb system is not applicable to trains which have to be subdivided in route, but is convenient for the main-line express trains. He also states that the Lewis system had only been in regular work for three months when he

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obtained the figures, and that they may therefore be too favourable.

COST OF TRAIN-LIGHTING IN AMERICA.

System of lighting.	Cost of fitting per carriage.	Total c.p. of lamps per carriage.	Cost of lighting	
			Per carriage per day.	Per c.p.-hour in pence.
Electric.	£ s. d.		s. d.	
(*a*) Direct from dynamo—G. Gibb	67 12 0	288	3 11	·0162
(*b*) Dynamo and accumulators—Pullman Company	193 12 0	360	7 11½	·0264
(*c*) Accumulators only—Pullman Company	130 0 0	482	6 9½	·0210
(*d*) Accumulators only—Chesapeake and Ohio Railway	141 16 0	148	3 9¼	·0246
(*e*) Dynamo and accumulators—Lewis system .. Gas.	100 0 0	192	1 11	·0117
(*f*) Pintsch gas	80 0 0	148	3 9¼	·0306
(*g*) Oil	14 8 0	148	2 6½	·0206

In conclusion, I have to thank the engineers of the various railway companies for the generous way in which they placed the information gained by years of careful work at my disposal. Also I am indebted to them for many of the drawings which have accompanied my descriptions.

TRAMWAYS INSTITUTE OF GREAT BRITAIN AND IRELAND.

The annual general meeting of this institution was held at the Holborn Restaurant yesterday (Thursday). In the absence of the president, Mr. Carruthers Wain, the chair was occupied by Mr. Mason.

Mr. JOSEPH M. SMITH moved the re-election of Mr. Carruthers Wain as president, which motion was carried. Mr. William Neale, of the Birmingham tramways, was added to the list of vice-presidents. The auditors were re-elected. It was agreed that the next meeting of the institution should be held in the Isle of Man in September next. Mr. MASON suggested that the winter was a bad time for holding a meeting, and that the "quarterly meeting" in the winter months should be held "half-yearly." This was approved of. It was decided that the spring meeting should be held in Birmingham.

Mr. ALFRED DICKENSON opened a discussion on "Traction up to Date," with special reference to the report to the Newcastle Town Council by Mr. W. G. Laws, their city engineer. Mr. Laws had recommended the use of cable tramways as being specially applicable to his district. The figures and facts given by Mr. Laws had been dealt with in very cavalier fashion. A cable line could not be constructed at anything like the price stated by Mr. Laws. The cost of the Brixton cable could not be ascertained, the secretary having instructions not to give any information; £200,000 would, however. be about the cost of that line. The construction of the road bed alone would be £10,000 a mile, and it was absurd for Mr. Laws to suggest that a cable line could be carried out with equipments for £10,000 a mile.

At this point Mr. CARRUTHERS WAIN appeared and took the chair, and apologised for being late, he having been thrown out of a cab in coming away from the meeting the previous evening held at the Foreign Office in connection with the Railway Congress. He had been charged with the mission from the institute to show how much extension was possible if the Board of Trade could be shown the advantage of giving the tramway companies fair-play. There was little to be thankful for in connection with light railways, but he was informed that the Board of Trade were open to approve of a Bill ameliorating the condition of tramway traction. It had been suggested that the question of reserve funds should rather be considered by the institute than new inventions, but he considered that the council would not be doing their duty if they did not afford every facility for trying new inventions. The institution had to be kept in constant touch with Westminster, as when they successfully opposed the transference of powers from the Board of Trade to local authorities. The institute had opposed the London County Council's Tramways Bill and the Eight Hours' Bill, the London County Council's Valuation Bill, and the question of betterment. The institute could be made far more effective if the other companies not associated with them would join them. The tramways were not at present a united industry, though they should be. He had two years ago advocated electric welding of tramway rails, which had been scoffed at then, but it had been successfully dealt with in America. While at one time electric traction by overhead wires would have been condemned here, the Stafford tramways showed that there was now a more reasonable condition of affairs. He found that where an improved service was to be given, there was a disposition on the part of the municipalities with whom he had to deal to grant extended leases. He questioned whether a municipality could work a tramway line as economically as a company. The Glasgow Corporation, for example, were not actually making a profit. His opinion was that they were being worked at a dead loss, and this would be shown when undeceptive accounts were produced.

The report of the institute was then read, in which it was pointed out that they had opposed legislative encroachment on tramway enterprise. Unity among tramway companies was urgently required. Mr. Wain had represented the institute on the light railways enquiry. There was great scope for development of tramways by private enterprise. The report was adopted.

Mr. ROBINSON suggested that a movement might be made to get shareholders of tramway companies to join the institute.

Mr. ROTHWELL resumed the discussion on Mr. Laws's report. He was sure that the report was quite absurd.

Mr. ELLIOTT said that Mr. Laws considered that he could not take part in the discussion on the matter owing to his position.

Mr. WAIN said that the ideal horse was the best motive power in certain districts, steam in others, cable elsewhere, overhead electric traction where towns had to be united. All forms of traction had their limits, and also special facilities. What was wanted was the best means of adapting traffic to the requirements of the district dealt with.

Mr. TURTON, of Leeds, said they had been greatly hampered by the Municipality in working their lines. Now that the Corporation had got the lines, they should be able to make a profit of 15 per cent. They had, of course, the advantage of getting their capital at 3 per cent. Steam had been the life of many lines.

Mr. MASON said that the total profit made at Leeds was £56 for 14 months.

Mr. SCOTT RUSSELL said that Mr. Laws appeared to have started with the intention of advocating cable against other systems, and had done so—an easy matter enough, for it was simple to pick holes in other systems. Mr. Siemens had demolished the objections to the underground electric conduit system. At Northfleet no difficulty had been experienced in connection with the ⅝in. slots on the electric tramway there. The conduit system should have a good future.

Mr. CONRADI had for years studied the question of the best mode of traction, and it was best to use steam in preference to any other mechanical motor. Electricity had made great strides in America, but he did not think that overhead wires were suitable here. Improvements might, however, be made in connection with accumulators and lead to developments.

Mr. SELLON said that Mr. Laws had been misled by not having gone to the proper sources for his information. The voice of Mr. Colam appeared throughout Mr. Laws's report. Cable traction was not suitable for narrow streets like those of Newcastle. The report could not commend itself to tramway men.

Mr. W. NEALE, of Birmingham, did not think that there was nothing like the steam-engine, as some speakers had said. He preferred cables to steam, complaints being made as to steam-cars. They had a good accumulator

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system, but it had proved a loss, the line (the Bristol-road) being a suburban one with but little traffic. It would not pay to lay down a cable there, but he agreed that accumulator traction might have a good future. Their horse-traction lines did not pay at all.

Mr. GEORGE CAWLEY, M.I.M.E., then read his paper on the "Thwaite and Cawley's System of Electric Haulage," which we print elsewhere.

Mr. COOPER stated, in connection with the paper, that the use of refuse destructors in connection with the generation of steam for the stations for such a line proved economical. About 3½lb. of refuse was equivalent to 1lb. of coal.

Mr. A. G. NEW next read the following paper on

The I.E.S. Storage Battery for Lighting and Traction.

The storage of energy of all kinds is one of the most important problems of the day, and particularly the storage of electricity. The chief objects to be borne in mind in the design of storage apparatus of all descriptions are: firstly, efficiency; secondly, compactness and lightness.

As regards the first of these, when dealing with electrical accumulators, a very fairly high efficiency—when the batteries are new—is obtainable, but the chief difficulty in the past has been to obtain a large capacity with a small amount of weight and size, and to obtain a battery in which the plates do not rapidly deteriorate under electrical or mechanical strains. Up to the present time lead is the only material which can be used efficiently for the construction of plates for this purpose, and its high specific gravity naturally involves great weight.

It may not be out of place to briefly summarise the existing forms of accumulator plates which have been made in the past, as it will then be easier to point out the advantages which are possessed by those known as the I.E.S. The plate which has probably commanded the highest sales has been the E.P.S. plate, and this consists of a grid formed of pure lead constructed in such a way as to have cavities on its surface for holding the active material, oxide of lead. The Epstein and other forms of Planté plates have the active material electrolytically formed in place from metallic lead, but these being very solid are very heavy. Other forms of plates have been made in which fibrous substances are mixed with the active material in order to bind it and prevent its falling away. Practice shows that when an accumulator plate is subjected to charging the active material expands, and that this expansion is no mere theoretical amount, but sufficiently noticeable to render the adhesion of the oxide to any other portion of the plate which does not expand a difficulty. In the type of plate known as the E.P.S., the expansion of the oxide of lead plugs tends to stretch their leaden seatings, and consequently when they again contract they only fit loosely in their places—the harm thus brought about being twofold: firstly, bad contact; and, secondly, a tendency for sulphating to take place.

Another important point in the construction of accumulator plates is to obtain as large an active surface as possible and, by avoiding any actual contact between the lead conductor and the acid, to prevent any rotting away of the lead. The disadvantages arising from the neglect of these two most important points is noticeable to anyone using the E.P.S. accumulator. Experiments which have been carried out within recent years by the inventors and proprietors of the patents now being worked under the name of the I.E.S. accumulator, have shown that the most essential points in the construction of plates are the following:

1. The conductor should be as light as possible consistent with being made of pure lead, and being within a short distance of every particle of the active material. It should, moreover, be entirely covered by the active material, and under no conditions should it come into contact with the electrolyte. It should be, at all points, covered to such a depth with the oxide that no electrolytic action takes place upon itself.

2. The active material should offer as large a surface to the electrolyte as possible, and should be so held as to be able to contract and expand without loosening itself from the conductor or allowing particles of its surface to fall away. The shape of the plate should be such as to require the smallest quantity of active material consistent with an equal and sufficient depth of active material over every part of the conductor. On no account should it be possible for the oxide to shift or for its particles to travel when being used.

3. The general formation of the plate should be such that any mechanical contrivance for holding the active material in place is capable not only of allowing it to expand but also of contracting with it when it contracts—that is to say, the holding-in material should be sufficiently elastic to keep the complete plate in rigid and secure condition at all times.

The I.E.S. plate fulfils as far as is possible at the present time, and with the present amount of practical experience, all these conditions, being constructed in the following manner: The conductor is made of lead shaped into a grid somewhat like a comb, and this grid is then fitted with strips of perforated sheet celluloid in the manner which has proved most successful from a practical point of view. The active material is then laid on, and the whole plate at this stage of its manufacture presents a surface entirely composed of the lead oxide. It is then slipped into a perforated celluloid envelope which it fits closely. The plate is then ready for use, and after its first formation by charging settles down into a solid and compact plate, which, however, can freely expand and contract to the required extent, and in which no travelling or movement of the particles of the active material can take place. The capacity of the I.E.S. plate is shown by experiment to be from three to five times that of an E.P.S. plate of the same size and surface. It is, moreover, capable of standing heavy charges and discharges to an extent which would soon destroy an E.P.S. plate. It will be seen that for traction purposes the I.E.S. plate is eminently suitable, and it is, in fact, at the present time the only accumulator in the market which is adapted for that purpose.

The cause of the enormous rate of depreciation in most accumulators previously tried for traction purposes is the jolting and constant vibration when in use and when at the same time expanding or contracting, which forces the particles of the active material to dislodge themselves and—in the case of the E.P.S. plate—causes the plugs to jerk out, thus forming a deposit at the bottom of the cell; this deposit not only has an injurious effect electrically, but also represents loss of active surface, and consequently impaired capacity in the cell. Experiment shows definitely and clearly that no deposit forms when using the I.E.S. plates, even on the roughest roads or when subjected to considerable vibration and jolting.

The cost of lighting trams by means of the I.E.S. batteries is doubtless a point of special interest, and I will, therefore, briefly show the exact cost per annum of lighting the cars which recently have been fitted up on the North Staffordshire Company's line. In the first place, I may mention that the complete battery for each car weighs about 54lb., is 13½ by 7½ by 7½ over all, and has a capacity of 40 ampere-hours at 16 volts. The total charging current necessary per battery per charge is 800 watt-hours, which is 1·072 electrical horse-power hours. Taking the actual cost of generation of current at 2d. per electrical horse-power, this represents a cost of 2·144d. The battery, when fully charged, is capable of lighting one 5-c.p., two 3½-c.p., and two 2½-c.p. lamps for 11½ hours, giving during that time a total light of 17 c.p.—the cost per car per hour being ·1861d. Taking 2,000 working hours per year, the annual cost of current per car is £1. 11s. The existing arrangement between the tramway company and the I.E.S. Company is one by which 2s. 6d. per week per car is paid as hire. This adds £6. 10s. per car per annum to the above cost; allowing and adding interest on capital expenditure for plant and fittings at 5 per cent., the annual cost per car is £8. 14s. 9d. If the tramway company were to purchase the batteries, instead of hiring them, the total cost to themselves per car per annum, after allowing 10 per cent. for depreciation and 5 per cent. interest on the extra outlay, would be £3. 11s. 9d., as against the previous £8. 14s. 9d. The total cost per five-light car per week is, therefore, as follows: (1 3s. 4¼d. hiring; (2) 1s. 4½d. purchasing—and these figures are obtained without the necessity of disfiguring the electric fittings and reflectors with advertisements.

For traction purposes the I.E.S. accumulator enables stored electricity to be carried with an extremely low weight as compared with any other accumulator in the market. A positive plate having 30 square inches of active surface (each side) has a capacity of 30 ampere-hours at a discharge of five amperes, weighing 30oz. This result brought down to units represents one square inch of plate, one ampere-hour, two watt-hours, 1oz. Allowing an 80 per cent. efficiency for the electric motor, it would be necessary to have a storage capacity of 900 watt-hours in order to develop one horse-power hour. This, calculated on the basis given above, which has recently been considerably exceeded, represents an active surface of positive plate 450 square inches, and would weigh 28lb. Adding the weight of the negative plates (necessary for positives having this surface), the total weight of the battery necessary for one electrical horse-power hour is 61lb. (a discharge during six hours being allowed for).

Taking, now, trams similar to those on the Birmingham Central, and allowing for a six hours' capacity at an average of 7 h.p. during that time, thus equalling 42 horse-power hours, the total weight in plates for this would be 22cwt., or, adding weight of boxes and acid, gives a total of 27cwt. Assuming an average speed of five miles an hour during the whole of the six hours, it would equal a 30-mile run, and the total capacity being 42 horse-power hours, we find that 1·4 horse-power hours is necessary per car mile. Allowing a total efficiency of 56 per cent.—that is, 30 per cent. loss for storage, and a further 20 per cent. motor loss—and taking the actual cost per electrical horse-power generated at the charging station, including all labour, depreciation, etc., at 2d., the actual cost of current per car mile equals 4·032d.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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NOTICE.

We have received an unfinished letter from a correspondent in Storer-road, Loughborough. We are unable to reply to this letter because neither name nor number of house is attached.

LIGHT—MORE LIGHT.

Once again we may venture to point to the absurdity of public declamation against the amount of the bill for more light as compared with the amount of the bill for light. There is a strong tendency in civilisation to fight against Nature's laws. The hours of work may be shortened so far as the manual labourer is concerned, but to compete in business and ensure a return for capital sunk in machinery and other directions, relays of manual labour are called into operation. Nature says, Work while it is day; civilisation says, Work all day, and during as much of the night as possible. Business—and if we add to business recreation, still more so—means movement, and for its purposes plenty of light and means for locomotion are required. The growth of artificial light has been contemporaneous with what we term the growth of civilisation, and no doubt a century or two hence writers will ridicule the tendency of the nineteenth-century *fin-de-siecle* politician or biassed agitator to decry the necessary cost for more light. What is the history of the artificial lighting of public streets? Beckman, in his "History of Inventions," devotes a chapter to this subject, and points out that the lighting of streets, of whatever benefit it may be, is generally considered a modern invention. The Greeks and Romans—perhaps more sensible than their successors—preferred to follow Nature's dictates and worked while it was day, for there is no record to prove that the streets of Athens and Rome were lighted. The Romans, indeed, used flambeaux and lanterns for their nocturnal visits—nor, indeed, have we moderns entirely discarded their use. It is generally agreed, however, that during high days and holidays the streets, both under the Grecian and Roman *régime*, were illuminated. According to Beckman, the houses of the ancients were illuminated on birthdays by suspending lamps from chains, and in continuation of his narrative he states that, so far as he was able to learn, Paris set the example to the moderns of lighting its streets. This city, he says, in the beginning of the sixteenth century was much infested with street robbers and incendiaries, and the inhabitants were from time to time ordered to keep lights burning after nine in the evening before the windows of all the houses which fronted the street. Orders were issued to this effect in the year 1524, and again in 1526 and 1553. It will be remembered, if our recollection serves us rightly, that Mr. Preece, from the earliest introduction of the arc lamp, has again and again strongly urged upon municipalities the value of electric lighting, in that by its means more light is obtained, the streets are rendered brighter, and lawless individuals have thereby less chance of breaking the laws of the realm without being found out. He agrees, we presume, with most people in supposing that the moral attributes of man are in a rather low condition, and that many people would break the laws if they had no fear of being found out, and the best means as yet devised for repressing these law-breakers is to flood the whole place with light.

Paris commenced to light its streets with an apparatus called a *falot*, which seems to have been

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a receptacle filled with various combustibles, till the year 1558, when these lights were changed for lanterns. Again, quoting from our authority, we find that "in 1667 the lighting of the streets of Paris was put on that footing on which it is at present." (The date of Prof. Beckman's book was 1846.) Up to 1671 the streets were lighted only during the four winter months, and on account of the numberless atrocities committed during the nighttime when there were no lights, the Parisians offered to contribute as much money as should be sufficient to defray the expense of keeping the lamps lighted throughout the whole winter." It will be unnecessary to follow this archæologic theme through the whole of its course—if any one of our readers desires to know what Prof. Beckman wrote he will find the article in the second volume of Beckman's history, issued in the Bohn Standard Library.

It will be seen that the early ideas were almost wholly connected with getting rid of the desperadoes who luxuriated in the darkness, following the old adage, that men love the dark because their deeds are evil. We prefer to add to this argument, and insist that we want more light, not only for the purpose hitherto described, but for the purpose of ordinary business. With the introduction of better lights, as every reader knows, without attempting a detailed proof, business and manufacturing purposes have been carried out during longer hours. There is no doubt that the introduction of gas was of incalculable benefit to all industrial operations, and we should incline to the opinion that the introduction of electricity will be quite as beneficial to these operations as was the introduction of the earlier illuminant. It must be remembered that the later illuminant only dates from, say, 1878, when Jablochkoff introduced his candles, and electric lighting was for a few years subsequent to this only seen furtively, and existed under no very happy conditions. From 1881, however, its progress has been rapid, and we are glad to see that there is every indication of its being still more rapid in the immediate future. Those who advocate the policy of progress so far as public lighting is concerned, then, would do well to add to their list of arguments in pushing forward their operations the one we have referred to, and to continually point out that more work and better work can be carried out in a given time with a better light, and thus the cost of the materials produced is lessened, and an indirect benefit arises which ought to be, but is not usually, taken into account.

CONGRATULATIONS.

We tender our hearty congratulations to the Metropolitan Electric Supply Company on the able way in which their engineers have enabled them to overcome the disastrous fire at their Sardinia-street supply station. On Monday evening last, at a quarter-past six, a fire originated in the dynamo-room. In under an hour the whole of the roof had fallen in, and the concrete floor was some six inches deep in red-hot ashes. By half-past eight the same evening the whole of the theatres and buildings most urgently needing light on the company's mains in that district were again receiving supply. The trunk mains from Rathbone-place, Manchester-square, and Amberley-road enabled this to be done. Still, when it is known that the switchboards by which such connections are usually made were at that time utterly destroyed by fire, the promptitude of the engineer will be duly appreciated. The mains are fortunately led into a chamber on the ground floor, which escaped the fire, and in this temporary cross connections were made from the trunk mains to the district supply mains. As, however, the trunk mains were installed with a view of supplying light loads only, they were of insufficient section to carry the total current required. On Tuesday afternoon the drawing in of further trunk mains was in full swing, and by to-night the whole of the consumers will receive light. In this operation, again, an unexpected difficulty occurred. The intense heat of the sun during the last two days had softened the tarry covering of the wires, making it very sticky to handle. In this way the drawing-in process has been greatly retarded. On Tuesday the Sardinia-street dynamo-room presented a lamentable appearance. The alternators had all suffered from the baking process, and the overhead traveller had fallen across two of them. Only a few stray connections stood to mark the spot where the switchboard was. The engines, being protected by the concrete floor, have not suffered much, and the boiler-room escaped entirely. Great credit is due to Mr. A. H. Walton for the energy with which he overcame the difficulties of resuming supply, and his whole staff have most ably risen to the emergency. We understand that the extension previously being pushed forward, by which alternators driven by steam turbines are to be placed on a floor over the boilers, will now be completed shortly, and we have no fear that the public will suffer any further inconvenience. Certain private consumers who had to give place to the public demands when only a limited supply of current was available will, we are sure, bear with the company, and will now congratulate themselves that the engineers of the company had made such good provision against total failure when designing the system of supply.

TELEPHONY.

We understand that the Select Committee which has been taking evidence on this question resolved at its meeting on June 25, in view of the political situation, to report the evidence it has taken to Parliament, and recommend the reappointment of the committee next session. This probably means shelving the question for the current year.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE USES OF ACCUMULATORS.

SIR,—The report giving the substance of my remarks at the recent meeting of the Northern Society of Electrical Engineers has been condensed by the omission of so many

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important passages that I was hardly able to recognise parts of it.

It put words into my mouth regarding alternating currents which, when read without the other remarks which preceded and followed them, conveyed a totally false impression. I was at considerable pains to explain that the outcome of the long conflict which has raged between the advocates of continuous and alternating systems of supply has been to show that, however well suited alternating currents, whether monophase or polyphase, may be for power transmission or even for transmitting the energy for lighting purposes up to distribution centres, they are not well suited for employment in the distribution network—*i.e.*, from these distribution centres up to the consumers' lamps. That this was on account of those very peculiarities inherent in alternating or pulsating currents which, on account of the interesting problems involved, so endear them to the minds of professors and students, but which introduced practical difficulties in giving a perfectly regular and steady light free from pulsations.

I pointed out that the most successful way of dealing with these difficulties was to confine the alternating system to the transmission of energy up to the distribution point, to interpose the accumulators at this point, and consequently to use nothing but continuous currents in the network; and I pointed out that the very latest and best continental practice pointed in this direction.

All this matter, which was certainly given by me at as great a length as I have here written it, has been condensed by the report into five lines, in which I am made to say that I am strongly an anti-alternator man, and that alternating currents were no doubt a splendid thing in their way to professors and schoolboys, but nasty things to deal with in central stations.

I need hardly point out that such are not my opinions, and that I believe that alternating currents are playing and will play an important part in the electrical industry, and the brief summary of my opinions given in your "notes" is both unfair to me and misleading to your readers.—Yours, etc.,

R. E. CROMPTON.

Thriplands, Kensington Court, W.,
June 25, 1895.

INCANDESCENT LAMPS.

SIR,—In your issue of the 21st inst., your reporter has fallen into an error in stating that it was after the publication of the Swan *patent* that Mr. Edison abandoned platinum and adopted carbon in his incandescence lamp.

Unfortunately, the Swan *patent* was not applied for till after Edison's; but, as was shown at the trials in the law courts, lamps made by Mr. Swan and myself had been publicly exhibited in Newcastle and elsewhere before the date of Mr. Edison's patent of 1879; and if not in all respects quite up to the standard of the present day, they were at least better than any described in that absurd patent.

The question at issue in the courts was not whether the Swan *patent* was antecedent to the Edison, but whether the Edison patent was rendered invalid by the public exhibition of the lamps made at Newcastle and Rock Ferry by Mr. Swan and myself.

The result, as your reporter observes, was "*astounding.*"

Yours, etc.,

C. H. STEARN.

47, Victoria-street, Westminster,
June 21, 1895.

THE BURTON-ON-TRENT TENDERS.

SIR,—We notice in this week's issue you state that our tender for the cast-iron pipes for the extensions at Burton-on-Trent has been accepted. This, however, is hardly correct—our tender, which has been accepted, being for the high and low tension *cables*.—Yours, etc.,

THE TELEGRAPH MANUFACTURING COMPANY, LIMITED
(Per James Taylor, Director).

Britannia Telegraph Works, Helsby, near Birmingham,
June 22, 1895.

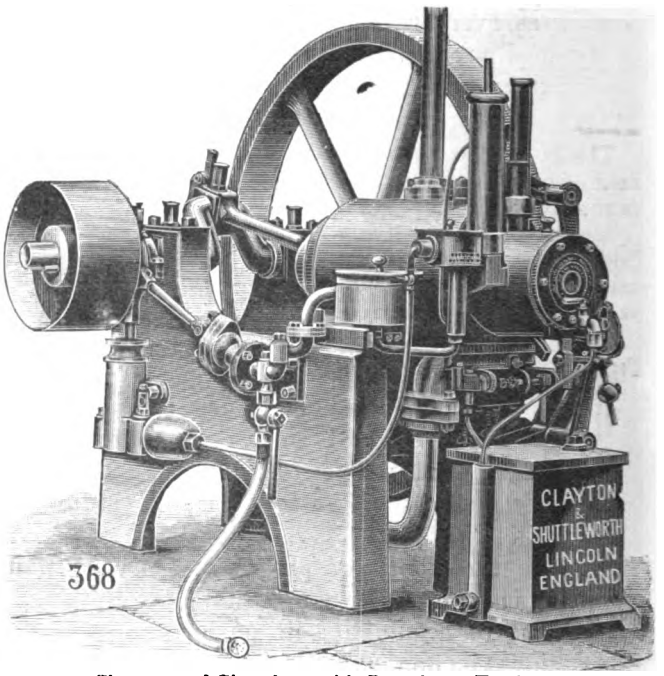
ELECTRICITY AT THE ROYAL SHOW.

Special telegraphic and telephonic arrangements had, of course, to be made in connection with the visit of the Royal Agricultural Society's Show to Darlington. Four Wheatstone instruments were connected with four special wires to the show ground, by means of which direct communication was established to London, York, Leeds, Birmingham, Manchester, Liverpool, Newcastle, Edinburgh, Glasgow, Aberdeen, and Dundee.

We understand that the postal and telegraphic business so far done considerably exceeds that of the corresponding period of the Cambridge show of last year. The telephone department was arranged by Mr. J. McKenzie, of Middlesbrough, manager for the Durham district of the National Telephone Company, whose acting representatives are Mr. A. T. M. Mushans, of Hartlepool, and Mr. J. T. Tattersall, inspector in charge, Darlington. The call office is situated near the Royal pavilion, and contains an efficient equipment of instruments, with switchboard for 12 lines, there being two trunk lines from the show ground to the exchange at Darlington. The public have the use of the call office, a charge of 3d. being made for communication with any part of Darlington.

There was a tolerably good exhibition of electrical machinery in the grounds.

Messrs. CLAYTON and SHUTTLEWORTH, of Lincoln, and 95, Queen Victoria-street, London, exhibit on Stand No. 7 a petroleum-engine (Knight and Weyman's patent) of 7 b.h.p., suitable for barn machinery, electric lighting, etc., of the type shown in the accompanying cut. This engine



Clayton and Shuttleworth's Petroleum Engine.

has been designed for using the common oils—such as petroleum and the ordinary lamp oils; the heavier oils can also be used. It acts upon the four-cycle principle—an impulse being obtained every other revolution—and it is fitted with a small oil pump and a vaporiser, the latter being placed at the end of the cylinder. The oil is contained in a small tank, which can be placed in any convenient position in the engine-house. The tank is connected by a pipe to the small pump, which is actuated by the governor of the engine.

Messrs. GREENWOOD and BATLEY, LIMITED, of Albion Works, Leeds, show their electric motors of ¼ h.p., ½ h.p., and 1 h.p., the main features of which are: steel castings for magnets in all sizes, carbon brushes, and the ring method of lubrication. They show, further, an eight-unit dynamo, and an 8-h.p. motor driving an "Excel" pneumatic power hammer.

Messrs. JOHN FOWLER and Co., LIMITED, of Leeds, exhibit at Stand No. 107 an 8-h.p. semi-portable compound engine fitted with automatic gear on the high-pressure valve, specially adapted for electric lighting and similar work

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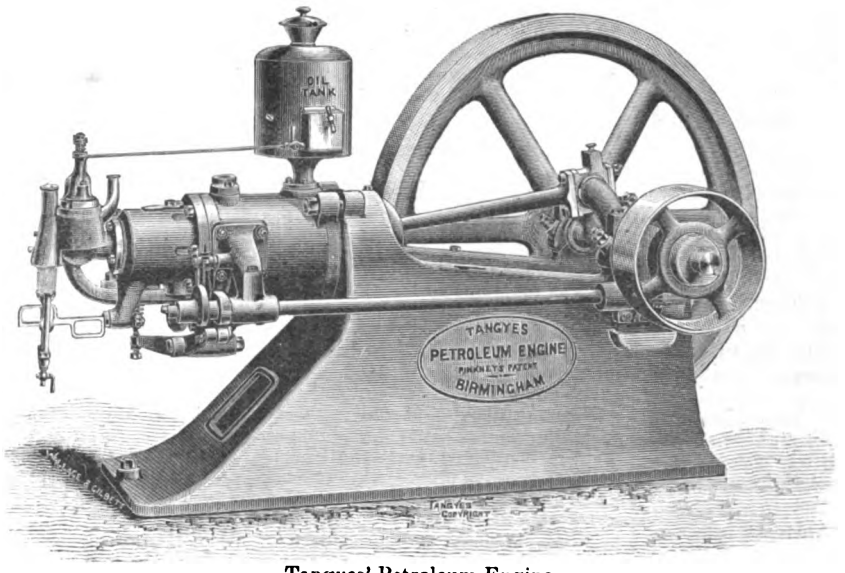
where steady running is essential; and a 13in. horizontal engine fitted with automatic expansion gear controlled by the governor, and, like the foregoing machine, specially adapted for electric lighting.

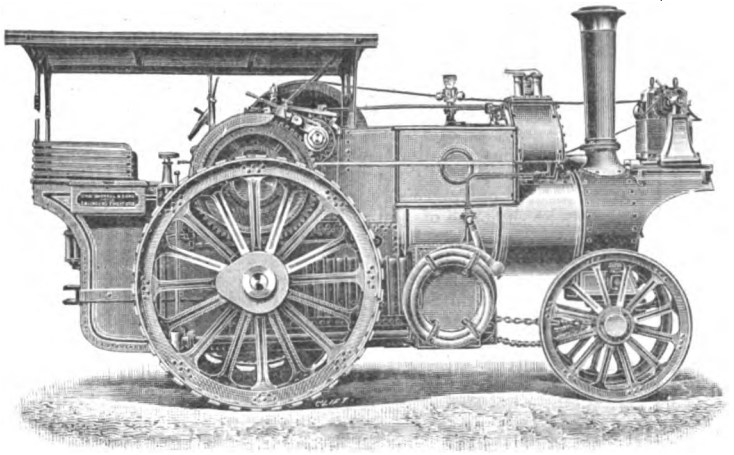
TANGYES, LIMITED, of Birmingham, have on view a 6 b.h.p. oil-engine driving a Siemens dynamo for electric lighting. This engine is built on the "Otto" principle, and is of simple construction, having only two valves—the inlet and exhaust. It has no fan for heating vaporiser, air or oil pumps, or air receiver. The explosion of charge is timed and effected by a small wickless oil lamp. The oil consumption under test at works is stated to be under one pint per brake horse-power per hour.



Tangyes' Petroleum Engine.

The HARDY PATENT PICK COMPANY, LIMITED, of Sheffield, show their well-known magnetic separator, for separating iron and steel from other material.

Messrs. CHARLES BURRELL and SONS, LIMITED, of St. Nicholas Works, Thetford, Norfolk, display one of their compound road locomotives, fitted with a dynamo in front, as shown in the annexed engraving.



Burrell and Sons' Road Locomotive.

Messrs. CROSSLEY BROS., LIMITED, of Manchester, display a special design of high-speed electric light engine, with extra heavy flywheel and out-end bearing, giving 28 b.h.p. (maximum) when working with coal gas; speed 250 revolutions a minute.

Mr. E. S. HINDLEY, of Bourton, Dorset, exhibits one of his dynamos and a high-speed electric lighting engine.

A METHOD OF ELECTRIC TRACTION FOR TRAMWAYS IN TOWNS—THE THWAITE-CAWLEY SYSTEM.*

BY GEORGE CAWLEY.

Any method having for its object the extension of efficiency and economy of transit, and put forward as a possible solution of a present difficulty, is, I may venture to presume, a matter suitable for consideration by the members of the Institute of Tramways of Great Britain and Ireland, as the mission of this institute is mainly connected with transit economy and efficiency, at least so far as the tramways of the United Kingdom are concerned.

Having this in view, and having also been kindly asked by your widely-esteemed president to read a paper before this meeting descriptive of a presumably novel method of electric tramway haulage recently patented by Mr. B. H. Thwaite and the writer, I thought I could not better show appreciation of the compliment paid me by your president than by readily complying with his request, even though I confine my remarks at the present time to a general outline of the scheme, leaving the most economical arrangement of the details for any given line as a matter for after consideration, and one which may, with the kind permission of your worthy president and council, form the subject of a supplemental paper on some future occasion.

There is not, I feel sure, the slightest need to make any kind of appeal to you with a view to convincing you either as to the practicability or advantages of electric traction on tramways. This being granted, then, the only questions really left for discussion are two—namely, first, which is the best electrical haulage method for any given line? for urban and suburban and outlying district lines demand treatment in accordance with their special requirements; and, secondly, how soon, having regard to financial and other preliminary difficulties, can our present horse haulage be supplanted by an electric haulage arrangement? The sooner this change can be put into practical form, the more speedily, as I hope to show, will the present not over-cumbersome profits made by owners of horse-hauled tramway lines assume a more satisfying and comforting proportion. That has been the general result in the United States after the conversion of horse-hauled lines to the electric system, and one may reasonably hope that a similar result would be effected in this country when suitable and well-considered urban and suburban electric methods have been fully adopted.

In confirmation of this, we have abundance of recent evidence, for within the last few months some thoroughly reliable information has been given on electric traction on American tramways by electrical experts who have studied the most recent developments on the spot. From this source we find that there are now some 600 electric tramways in the United States, operating nearly 9,000 miles of track and 20,000 cars. Also, that £45,000,000 has been already invested in electrical tramways, which now comprise nearly three-fourths of the entire tramway equipment of the country. This vast extension of the electric haulage system has been practically effected during the last five years. As in many other directions of industrial enterprise, the present state of perfection has been attained, to some extent, by a process of "trial and error," and "selection of the fittest" has been generally arrived at as a result of several years' working.

In many phases of industrial development, "John Bull" has been a pioneer, but as regards the subject under discussion he has wisely or unwisely lagged behind. As it often falls to the pioneer's lot to take a large share in "paying the piper," there may, perhaps, be some shadow of consolation in the present case in respect of the laggard action adopted so far by this country. We shall not, however, be able to comfort ourselves with that consolation much longer, except we also move forward and take advantage of the experience which the pioneering work of our American cousins, and also of our continental brethren, now affords us. From now we shall not even have left to us the excuse of commercial caution, for the financial success of the electric over the steam and horse hauled cars in America is proved up to full demonstration. A careful analysis of a large number of electric tramway accounts relating to continental and American practice has been recently made, with the result that the average working cost per car mile, leaving out only the item of interest upon capital, comes out as 6½d. in America and 5½d. in Europe. The ratio of working expenses to receipts, taking both Europe and America together, is approximately 60 per cent.

Comparing these figures with the corresponding ones obtained for our horse and steam tramways, we shall see that the latter are much higher, for the working cost per car mile for the latter comes out at about 10d., and the ratio of expenses to receipts

* Paper read before the Tramways Institute of Great Britain and Ireland.

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over 80 per cent.—in fact, for the London tramways it was a short time ago 82·7 per cent., and in some few places elsewhere in this country over 100 per cent. The authority for the latter figures is "Duncan's Tramway Annual." Probably some little rectification may be required to bring them up to date, but I think I may assume that the figures given are not materially wrong at the present time, as they correspond with the figures for American tramways before the application of electrical power for haulage. For example, in the State of Massachusetts in 1888, at which time the whole of the tramcars in the State were either steam or horse hauled, the ratio of expenses to receipts was 81·07 per cent. In 1889 a commencement was made on these tram lines with electric traction, and by 1893 the ratio was reduced, as a consequence, to 69·26 per cent. Further, in 1888, the net earnings per car mile was only 2·78d., while in 1893 it was 4·82d. Again, the net earnings per passenger carried in 1888 were 0·48d., while in 1893 they were 0·78d. In 1888 there was throughout the State a total track mileage of 534 miles, while in 1893 the mileage had been increased to 874 miles, of which 711 miles were driven electrically. The foregoing figures, gathered from American practice, emphatically plead the cause of electric traction as regards this country, and all the more forcibly when it is recollected that the decrease in the percentage of working costs to gross receipts was effected in American practice at a time when large investments had to be made for electric plant to displace the former plant, and that the value of the old plant had to be materially discounted or written off altogether. As bearing on the development of tramway enterprise on the other side of the Atlantic, it may be mentioned that Boston, with a population of only about a tenth of that of London, has over twice the number of cars in operation. In fact, it can boast of having the largest tramway equipment in the world.

Enough has been given to show that we have plenty of ground to make up if we wish to place ourselves on a level with electric tramway enterprise in America. If it be granted that this is desirable, we have, as a first consideration, to decide which is the most suitable method to adopt, and this opens up a large question. The salient points which govern the selection of a system vary, of course, not only with the district, but with the country in which the given line is to be built. For example, the electrical haulage methods allowed and adopted in American cities would not be generally permitted on similar lines in this country. The overhead single-trolley system, almost universally adopted in American towns—the so-called "deadly trolley" of the American newspaper reporter which caused an immense scare, and also several deaths, a few years ago—would not be generally accepted by the local authorities in our large towns, evidence of which we see in the action of the London County Council. When the matter was discussed by this important body on January 29 last, a large majority decided against the overhead system in the case of the West Metropolitan Tramways. In this discussion Mr. John Burns referred to the overhead system at Leeds, and said that he had noticed there "more kitetails entangled in the wires than he should have thought it possible for any community of boys to have produced in 50 years."

In the case, then, of lines in our large towns we should probably be compelled to adopt either the conduit or the storage battery system—that is, we must either derive our supply of electric energy from below ground or carry a supply of it in accumulators on the car. Only a short time ago, Dr. Preller, in a valuable paper on electric traction read a few months ago, stated: "It is not generally recognised that the overhead trolley system—much as it has been improved—is in reality only a makeshift, and is unsuited for the central parts of large towns. In these cases the conduit system or accumulator cars are therefore at present the only practicable solution of the problem. In Europe, the conduit system, whether it be that of Budapest or with a central slot, may be estimated to cost complete at least £10,000 per mile of single line and upwards, according to local conditions, though this is not too costly having regard to the enormous traffic in large towns; but its efficient working presupposes, among other things, perfect drainage of the trench. As regards accumulator cars, they would really constitute an ideal form of electrical tramway traction in towns, if the present weight of 12 to 15 tons, and the power and traction expenses of 8d. to 10d. per car mile, could be reduced to one-half."

As regards the latter method, it is fairly simply applied without disturbance of the line, but, for reasons of working cost alone, it does not appear to be the method which will be permanently adopted in English practice, except accumulators can be improved and lessened in weight. We then have the conduit, or culvert, system, and this is, no doubt, a relatively costly system to construct; but on account of the scope it gives for embodying practical solidity and durability in the working details, and to the convenient disposition of the conductors below ground, it is, I venture to think, the system that will be chiefly adopted for tramways in towns where electric haulage is used.

Although the conduit system has been adopted in several places in the United States and on the Continent, there is only one example of this system in this country—namely, the line at Blackpool, erected some years ago by Mr. Holroyd Smith. It is only fair to Mr. Smith to state that the Blackpool line is a very creditable piece of pioneer work. It was constructed at a time when practical experience was wanting as regards the electric system of haulage, and the constructor had to rely on his own experience as an engineer for guidance as to the practical fitness of the details embodied in his scheme.

With regard to the success of the conduit system so far as it has been applied, the opinions even of experts widely differ. One American expert, in referring to the conduit systems erected in the United States, stated a short time ago: "There have been in this country at least four practical experiments with conduit rails, and several hundred thousand dollars have been expended in testing them. In spite of all this refinement and study, practically nothing has been accomplished, and I have no hesitation in saying that the continuous-line conductor in an open-slotted conduit is to-day a failure, its fatal weakness being our inability to prevent the conduit from becoming filled with water, mud, etc."

(To be continued.)

LEEDS TRAMWAYS.

A report of the Sub-Highways (Tramways) Committee to the Highways Committee of the Leeds City Council, of their investigations as to tramway traction, and recommendations thereon, has just been issued, which contains a good deal of interesting information.

The sub-committee was first appointed by the Highways Committee on December 13, 1893, by the following resolution: "That a sub-committee, consisting of the chairman, deputy-chairman, Aldermen Ward and North, and Councillors Mart, Hannam, Metcalfe, and Boston be appointed to take cognisance of all matters connected with the transfer to the Corporation of the Leeds tramways undertaking and the temporary working thereof by the Corporation; also to consider the future working and mode of traction to be adopted." It was reappointed on November 12 last and now consists of Aldermen Firth, Hepworth, Scupham, and Ward, and Councillors Boston, Carter, Denison, Goodson, Hannam, Henry, Mart, and Moody. The undertaking of the Leeds Tramways Company was formally taken over by the Corporation on February 2, 1894, and since that time the purchased tramways have been worked by the Corporation pending a decision as to the motive power of the future and the necessary relaying of the lines consequent thereon.

The tramways purchased by the Corporation from the Leeds Tramways Company, reckoned as single line, are 22 miles. In addition, the Corporation own the Roundhay and Beckett-street tramways, amounting to five miles. The total length of lines (single track) laid and to be laid is 42 miles.

Before the sub-committee was appointed, a deputation from the Corporation visited Birmingham and inspected the four systems of haulage in operation there—viz., cable, electric (accumulators), steam, and horse. The various lines and the respective power stations were visited, and the deputation noted the advantages and disadvantages of the various systems. The horse and steam departments have similar features to those in Leeds, both as to cost and income. The accumulator electric system is very far from a success commercially, and the sulphuric acid in the accumulators at the time of the visit gave out a disagreeable smell to the passengers. This, however, it is claimed, has long since been obviated, and that it is not a permanent feature of the running, nor indeed a necessity of the case at all.

In the months of September and October, 1893, first the sub-committee and then the General Committee inspected the electrical overhead tramways at Darlaston and Walsall, the property of the South Staffordshire Tramways Company. The system differs from that of the Thomson-Houston Company, as established in Roundhay-road, in the fact that the posts and wires are on one side of the road only, with one wire for single track and two for passing-places and double lines. The promoters claim this feature as superior to the corresponding part of the system of the Thomson-Houston Company. This claim seemed to be a just one, as no wires crossed the streets, and many less guy wires were required to pass round corners. The tramway company equipped their lines originally with steam-engines, but having received an intimation from the Corporation of Walsall that a renewal of their license to use steam would be opposed, the company deputed their general manager and engineer to visit America, and there learn the facts as to the cable and electric overhead systems of haulage. The result of this visit was that the company entered into an arrangement with the Electric Construction Corporation to equip their lines with the electric overhead system. By this arrangement the tramway company were not to pay the whole cost of the installation, and the running was to be done by the Electric Construction Corporation, and on both accounts the company agreed to pay a total of 9d. per car mile for a period of five years. This amount has since been reduced, pending a decision of the law courts on questions which have arisen between the two companies. On this system, a very noticeable feature is the double decked cars, small single cars being the custom in other countries. Your committee were very pleased to have this demonstration of a double-decked car being used.

In June last, the sub-committee visited Newcastle, where there are 14 miles of tramway (taken as single track). The Newcastle

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Corporation have such a very determined objection to the wires and poles of the overhead electric system, that in giving their instructions to their engineer to report they excluded even the consideration of the overhead system, of which, therefore, your committee could not here glean any information.

The sub-committee visited Glasgow, where the Glasgow Corporation, in view of the working of the tramways falling into their hands, have fully considered the subject of tramway traction, including horse (the only haulage now used by them), compressed air, oil, and gas, as well as electric and cable. Their general conclusion appears to be that horse haulage should be discontinued as soon as possible, that compressed-air, oil, and gas motors have not to the present time been so far perfected as to make their adoption practicable, and that as between cable and electricity they say their town is well suited for cable, that overhead electricity would not suit them in the heart of the city on account of its unsightliness, though it might do in the outskirts. They have not arrived at a definite opinion as to the respective merits of cable and overhead electric traction, believing, however, that each has a merit, and that the special circumstances of the tramway routes must be carefully considered before determining which system should be adopted. The Corporation have been working their tramways since July 1 last. It has been a very large addition to the labours of the Corporation.

On August 29 last, the sub-committee visited the Isle of Man and inspected the tramways there, which belong to the Isle of Man Tramways and Electric Power Company. They consist of a line of horse tramways along the promenade at Douglas about two miles in length, and a double line of electric tramways seven miles long, being 14 miles of single track. This system is overhead, but instead of the trolley a collector bar is used on each end of each car, the patent of Dr. John Hopkinson. It is, in fact, a railway and not a tramway, and is placed wholly on land belonging to the tramways company abutting on the road from Douglas to Groudle but not so abutting from Groudle to Laxey, though crossing in two or three places. An important feature of the Isle of Man electric traction is the "cut-out" switches which are provided at certain points along the line, about three-quarters of a mile apart, with the result that in case of a breakdown by failure of current, etc., the section between the two cut-outs only is affected. There are two generating stations—one at Douglas and one at Laxey, being at each end of the route. Another speciality of this line is the accumulator station at Groudle, which contains a battery of 240 cells. From this station 100 e.h.p. can be supplied for 4½ hours, or 50 e.h.p. for 10 hours. Sometimes the company have supplied as much as 150 e.h.p. for a short time from this station. The cells are always automatically charging or discharging according to whether the generating station is making sufficient electricity or not for the motors running on the lines. This arrangement of storing surplus power enables the company to run their stationary engines and dynamos at nearly full load for the whole of the day, and in this regard effects a saving in the consumption of fuel. The cells are of a new type (the chloride), and it is claimed for them there is only a loss of electricity of about 20 per cent., and that this is more than covered by the increased saving in coal and wear and tear of plant.

At Brussels we found a very complete and well laid out sample of the Thomson-Houston overhead system. There are two lines electrically operated, having a total length of about 19 miles, and a total of 35 motor cars, each one of which takes a trail-car. Before the introduction of the electric system, a large portion of the line was worked by steam; and although the municipal authorities at Brussels opposed very strongly the introduction of the overhead wires, yet the Belgian Government and public opinion caused them to give way, and the satisfaction now given is very great. Along the route the difference is very marked. With the steam locomotives, the smoke, coal dust, and condensed water made the route most unpleasant. Now the state of things is very different. Inside the town itself the overhead wires are mostly fixed on steel posts with arms carrying the trolley wire, so that there is very little cross suspension. Outside the town, in places, wooden posts are used. The trolley wire is cut into sections electrically so as to separate each quarter mile. This is a great convenience, and enables repairs and other work to be done without affecting the general working of the line, and is of much importance in case of fires along the route. The feeders are carried under the ground and are tapped into the trolley wire at frequent intervals, thus keeping the pressure very constant. Lightning arresters are used along the line, and have proved useful in several severe storms. The electric system fulfils the requirements of the public much better than the steam trains, which consisted of four or five cars making a journey every half-hour. At present the electric cars run every 15 minutes in each direction. In the city itself the service is much more frequent, cars following one another at intervals of four minutes. The increase of traffic since the lines have been opened we are informed is very considerable, amounting to 100 per cent. Along parts of the road the speed reaches 16 miles an hour, and the gradients are steep, amounting in one case to 1 in 16. There are two generating stations. In one there are three Babcock and Wilcox water-tube boilers, with three Macintosh and Seymour engines, and three Thomson-Houston generators, 100 kilowatts (133 e.h.p.) each; water for condensing is obtained from the Seynne by an underground canal 250 yards long. In the other generating station there are also Babcock and Wilcox boilers, Macintosh and Seymour engines, and five Thomson-Houston 100-kilowatt (133 e.h.p.) generators, with room for three more units. Water for condensing not being convenient, this generating station is running non-condensing. The actual cost of traction (power and maintenance) is 1·79d. per car mile for one concern and 2·78d. for the other.

In Paris the tramways are worked by compressed air and accumulators. These are most expensive systems, and the compressed air has the additional drawback of having a very large, ugly, and heavy engine and car combined.

At Havre is one of the most complete examples in Europe of electric traction on the Thomson-Houston overhead system. The whole of the network of the Havre trams, originally operated by horses, is now electrically equipped. We found nine miles actually in work, and extensions were already in progress. This nine miles is largely double track, and is equivalent to 15 miles of single track. The gauge is 4ft. 8½in., the steepest gradient is 1 in 23, and the smallest curve has a radius of 58ft. 6in. There are 40 motor cars each divided into first and second class, and each car has a carrying capacity of 50 passengers. The cars are fitted up in very good style, and the electric equipment is of the latest Thomson-Houston pattern. The speed and direction are well under control from either end of the car. They run smoothly and quietly, and are lighted electrically. The overhead line is a good example of this class of work. In the narrow streets the wires are suspended over the track by cross-wires of steel, fixed in some cases to ornamental brackets let into the walls of the house, and in other cases by steel posts. In the broader boulevards there are centre posts with ornamental arms on each side carrying the trolley wire, and electric lamps are placed on the top of every other post. The effect is extremely good. The posts are 29ft. long, sunk into the ground 6ft. 6in. They are made in four sections of steel tube, the joints being covered by cast-iron rings, and the base fitted with an ornamental casting. There are about 560 posts. Of this number, 85 have arc lamps on them lighting about 4½ miles of thoroughfare. We understand it is likely that the number of arc lamps is shortly to be increased. The generating plant is situated in the central station of the local electricity supply company, with whom the tramway company have made a contract for the supply of electric energy. The generators consist of three four-pole Thomson-Houston dynamos of 200 kilowatts (266 e.h.p.) each, at a pressure of 500 volts and a speed of 425 revolutions. The machines are over-compounded 10 per cent., so that the pressure on the feeders is maintained constant at 500 volts. The generators are each rope-driven by a Corliss-type condensing engine, running at 65 revolutions. Sea water is used for condensing, obtained from one of the docks. The car-shed is a fine erection, 63ft. in breadth and 225ft. in length. This will accommodate about 60 cars, and the entire movement of the cars is effected electrically. A repair shop is arranged in proximity to the car-shed, and the tools are all electrically operated. The equipment of the lines has only recently been completed—viz., in July last—but already in September the number of passengers carried was double that in the corresponding month of the previous year, when horse traction was used, and we understand that the contractor's guarantees as to running costs were more than realised. The actual cost of traction per car mile is 3·37d., and the receipts 11·2d.

The fitting up of the Roundhay tramway with the electric overhead system of haulage is the result of a concession from the Leeds Corporation to Mr. Graff-Baker, the representative at that time of the Thomson-Houston Company, but that gentleman has now for some time ceased to have any connection with the tramway, and it is worked by the British Thomson-Houston Company. The installation consists of a generating station at Burmantofts, where engines and dynamos are placed capable of giving out 130 effective horse-power. The electrical horse-power required for a whole working day averages 10 per car. There are five cars running. Each of the cars is fitted up with two 15 h.p. electric motors. The difference between the actual horse-power required to work a car and the horse-power fitted to a car is caused by the power required to start the car on the severest gradient. This difference also accounts for the generating power at the station having to be so much in excess of the average requirements of the cars. This drawback has been lately largely surmounted by improvement in the electrical machinery on the cars. The weight of the motor car is 6½ tons. Those now being built are five tons. On busy days the motor car commonly pulls a trailer car. The whole of the wires are overhead, supported by poles placed against the edging stones. They run about 7½ minutes' service. The installation commenced to run on October 29, 1891. Since that time not a single wire has been broken or an accident or inconvenience suffered by anyone by reason of the installation being an electric one. The accounts, in accordance with the terms of the concession, have been regularly audited by the Corporation auditor. It is claimed for this tramway that, like all other electric overhead installations, the traffic has increased more than it would have done by any other system. For the year ending November 10, 1892, the passengers numbered 720,069; from November 11, 1892, to August 28, 1893, the passengers numbered 659,376; and for the year ending August 28, 1894, the passengers numbered 931,055.

The sub-committee having thus obtained what information they could from other towns, and considered their detailed memoranda made during their visits, instructed the city engineer himself to consider the whole subject, both from the scientific and commercial point of view, and to submit to them his report thereon. This he has done, and a print thereof is appended hereto. The sub-committee have since met several times to consider it. The plan of this report leaves out of the question the incomes of the different systems.

As to the estimated price of the land for depôts, and as to the fact that a much higher price is put down for the central cable depôt than for the overhead electric depôt, it must be remembered that the former of necessity must be very centrally situated, whilst the latter need not be so, and looking at the sites available we think

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the prices in the estimate are reasonable and are just as between the systems. In regard to the indicated horse-power required as plant by the cable system, we find that, comparing it with the three cables working in England and providing a reasonable stand-by, the amount provided in the estimate is certainly not in excess. In Birmingham, for six miles, the average amount required is 180; in Edinburgh, for 5·4 miles, the average amount required is 130; in Brixton, for 5 5 miles, the average amount required is 220. The difference arises from the varying services, gradients, and angles. In the winter months, with snow and frost, the horse-power required is much greater than this. As to the same item for the electric overhead, we have had the actual electrical horse-power being used at Roundhay measured, and find that on a bad day for working the average amount required is 12·7 e.h.p. per car, whilst for a fine day it is only 6·7 e.h.p. As to the motor cars, there having been different statements made as to their weight, we have had one weighed and find it is 6¼ tons, and not 9½ tons. We are informed the motor cars now being built are only five tons. Taking for safety the present cars on a bad day as a basis, the 69 motor cars and seven trailer cars of the system dealt with by the report would only require an average of 920·75 e.h.p. to work them, and adding to this 25 per cent. for indicated horse-power and 450 i.h.p. as a stand-by, the total average indicated horse-power required would be 1,600. The indicated horse-power debited against the electric overhead is, however, 2,175, the difference being an allowance for fluctuation of load. Having regard to the more uniform demand for power that the 35 miles of our full tramway system will make compared with the smaller five miles of the Roundhay-road electric overhead tramway, and taking into account the great mechanical improvement made as to the fluctuations of the power required by each car, we are of opinion that the indicated horse-power debited against the electric overhead system is rather in excess of the requirements of the case than otherwise. As to the cost of engines and buildings, the engineer submitted the capital accounts as published of the House to House Electric Lighting Company. The total indicated horse-power of that company's installation being 1,800, as against the 2,175 i.h.p. of the electric overhead and the 1,200 i.h.p. of the cable system, your committee accept this basis as a sound one, preferring such an excellent guide to any estimate based on general, although professional, knowledge. As to the cable conduit, the price has been determined by a detailed estimate of the engineer. The engineer pointed out that his figure was less than the amount the cable conduit had cost in the other cases, but claims that the Leeds Corporation can do this cable work at the price named. As to the street work of the electric overhead system, that also is based on the engineer's estimate, which, however, whilst taking all wires except trolley wires as placed in iron pipes underground, places high rates on each item; and comparing the figures with those given in public papers, we think this estimate sufficient. As to the cars, in both systems the prices stated for the electric overhead are those of several years ago. There is no patent to prevent their being made by anyone, and your committee believe electric double-decked cars can be built at the price stated in the engineer's estimate.

The committee believe that a full tramway service will increase the number of passengers. Indeed, it is claimed that the ease and comfort of the electric cars at once increase the number of passengers. Be that as it may, should the service ultimately given be less than that assumed in the engineer's report, the alteration would be in favour of the electric overhead system and against the cable system. The engineer's provision as to capital account is, with a slight exception, the same in all cases. The capital account for land, buildings, and tramway track is to be paid off in 30 years, and for machinery and rolling-stock in 20 years. The exception is as to the electric motor cars. These—*i.e.*, the carriage proper, as well as the electrical machinery upon it—are taken as having an average life of only 10 years. In the case of renewals on all systems the same terms of years are given, and the same exception occurs against the electric overhead. It appears the payments for capital and renewals on account of these cars is put down at £11,800 per annum. We are struck with the severity of this charge, and believe that in practice the average life of the two parts of a car will be found to be much longer than 10 years, in which case the electric overhead system will give a greater saving than appears in the report. As to the other terms of years, the sub-committee believe them to be readily obtainable, particularly as the question of repayment by the London Vestries of capital expended on electric lighting stations has just been settled on easier terms than those in the engineer's estimate, after a thorough examination of the question by the London County Council, in conjunction with the Treasury. The terms agreed are 50 years for land, buildings, etc., and 20 years for machinery and all other purposes.

The price per car mile has been arrived at as follows for the electric overhead system. Although the company operating this system has not published its accounts, it is important to remember that the agreement between the Corporation and the company enables the Corporation to examine the books of the company, and that this has been done, and the following figures can therefore be accepted as most reliable: the Roundhay electric tramway for the last 12 months, with a seven to eight minutes' service has cost 5·76d. per car mile. The management and power station expenses included in this amount are ·71d. and ·65d. per car mile respectively. In the large installation contemplated this will be reduced ·21d. and ·32d. respectively, and the cost would then be 5·23d. car mile. Adding to this the ordinary repairs on 35 miles single track, at £50 per mile, and on 2,429,084 miles = ·17d. per car mile, the total cost per car mile becomes 5·40d.

After considering the engineer's report most exhaustively, and comparing it with the notes previously made by them, and reviewing the whole case, the sub-committee have come to the conclusion that the present dual system of haulage—viz., by steam and horse power—should be superseded; that oil, gas, and compressed air are at present impracticable; and that having regard to the many routes in Leeds, and the great length of each involving varying requirements as to frequency of service, and the fact that really steep gradients are here uncommon, they are unanimously of opinion, and recommend to the Highways Committee, that electrical traction is most suitable for the tramways of this city. They have not failed to consider the advantages of cable where the gradients are commonly steep and the streets mainly narrow, nor that cable is specially remunerative where the routes are short and thickly populated, thus rendering a frequent service practicable on all the lines equally, but these advantages only apply to Leeds to a very limited extent, and, on the whole, the committee's preference is decidedly in favour of electric traction, with overhead wires except in the centre of the city, say, from the junction of Briggate with Boar-lane to the dispensary in North-street, to the junction of Hunslet-lane with Hunslet New-road, to Queen-street in Wellington-street, and to the top of Park-row, and that within these limits an electric conduit system should be adopted. The sub-committee do not close their eyes to the fact that objections may be made to both the overhead and conduit systems of electric traction, and that it will no doubt be contended by some that the former will seriously disfigure the streets. This, however, is not considered an insuperable objection, and, moreover, it is believed that great improvements can be made in regard to them by reducing the number of wires overhead by placing the feeder wires underground (already provided for in the estimate), and also by dispensing with many of the poles by fixing wires and apparatus to buildings (power to do which is being asked for in the Bill before Parliament), and possibly by placing such poles as are necessary against buildings (instead of at the causeway edge) in some cases, and in other cases in the centre of the roads rather than on both sides thereof. At the same time it may be practicable to utilise these posts for electric lighting by arc lamps, greatly to the advantage of the districts in which they may be placed. Overhead electric traction will also avoid the danger to vehicular traffic caused by the extra metals required to form the slot along each of the two tracks for cable traction, it being impracticable in many parts of the city to allow the width of two passing vehicles on each side of the tramway. This difficulty will not, of course, be removed where the conduit system of electricity operates, which, however, would only cover about 2¾ miles in the centre of the city, where the streets are fairly level and of good width, out of the total of present and intended tramways of 41 miles.

The sub-committee would refer the Highways Committee to the engineer's report, which deals in detail with the commercial and practical advantages of the electric overhead system over the cable as it affects Leeds, with whose observations and conclusions they concur, but they do not consider it necessary to lengthen their report by repeating them. The sub-committee believe that the difference in the annual cost of the two systems will be more, rather than less, than that estimated by the engineer, but accepting his figures, find that, taking into account the 13 miles (single track) of tramways being applied for this parliamentary session, and not included in the engineer's estimate, the difference in annual cost between the cable system and the overhead electric system, combined with a central-conduit system, will be £13,880 in favour of the latter.

In addition to this, the sub-committee would specially point out that whilst they are of opinion that the electric overhead system has passed the experimental stage, its possible advantages have doubtless not yet reached the maximum. Improvements are anticipated in regard to the accumulator system. These, however, seem remote, but should they be successful, that system would be preferable to the electric overhead system. The sub-committee believe that electricity in some form will be the motive power of future tramways, and that therefore it is a matter of considerable importance to note that not only will the capital expenditure upon overhead electric traction be much smaller than upon the cable system, but that in case of alteration, or the subsequent adoption of a new method of electric traction, less loss will result in its adoption than would be sustained by a change from cable haulage to that of any other.

Engineer's Report.

Mr. Thomas Hewson, the city engineer, in his report says:

In accordance with your instructions I beg to submit a report on the various systems of tramway haulage. The systems which have been adopted are horse, steam, cable, and electric. The systems that have been put upon the market, but so far not adopted in this country, are oil-engines, gas-engines, and compressed-air engines. The latter power is in use in France, and gas-engines have just been installed in one of the German towns.

Looking at the many trials and many failures of compressed air as motive power, I dismiss it as one not to compare with the remaining three systems—viz., the present combined system of horses and steam-engines, the cable, and the electric, the latter being divided into three modes—viz., the overhead, the conduit, and the accumulator.

With an installation practically entirely new, and with practically double lines throughout, Leeds would have the smallest capital account per mile of route of any large town in England; and having previously eliminated from consideration all systems but cable and electricity, I now proceed to a comparison between these systems of haulage by ascertaining first, the capital, and second, the annual sum required for each, premising that it wil

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be found these estimates do not propose to utilise the spare heat at the refuse destructors, and that my reason for this is that even supposing the whole cost of fuel could be saved by utilising this heat, the saving would amount to less than the gain of having the electric overhead system at one central station, or the cable system at a minimum number of stations, and all of them in the right situation for coal, water, and economical working.

As to the various modes of the electric system, I think it is common knowledge that the accumulator and conduit modes have heretofore been so costly as to be prohibitive, and even to-day the accumulator mode, although the most desirable from the fact of its being self-contained and so requiring no fixed provision above or below the surface of the streets, is unfortunately still out of the market financially. Notwithstanding the many patents which have been taken out within the last few years, the cost per car mile is nearly double that of cable and of overhead electric at a 7½ minutes' service. It would therefore be a waste of time to give an estimate of its cost As to the conduit mode of electricity it is palpable it must cost more than the overhead mode, as, in addition to all the expenses which that mode has, it has the conduit to provide. Taking the cost of the Budapest tramway at £14,750 per mile of single track—which is the amount the official documents show to be the cost, and seeing that the cost of labour on the Continent is cheaper than in England it is certain the cost in England will be no less—this it will be found is £3,936 per mile more than the overhead electric mode would require, and on the Leeds mileage this would amount to a total of £137,760 of extra capital outlay. This fact, together with the difficulties attending the conduit mode, and absent from the overhead mode; the extra loss of power by leaks and short circuiting; the objection to a wide slot in the roadway; the great cost of cleansing the conduit to prevent short-circuiting; and the interference with the traffic by the frequent repairs, I consider also places this mode out of the running. I am now left with only the overhead mode of the electric system to make an estimate for to enable me to make a comparison between it, the present system, and the cable system—the only three systems now surviving in this report.

Estimate of cost of Leeds tramways, installed with electric overhead system of haulage, including remodelling, doubling the lines where single—except Beckett street, which is to be extended as single line to York-road—buildings, plant, and equipment necessary for a 7½ minutes' service, which, with overlappings will give services of 3¾ to 1⅞ minutes in the centre of the city:

12·05 miles of double track of overhead electric road construction (all feeder wires to be laid in pipes under footpath, and return leads under tracks), at £1,900 per mile of double track		£22,900
5·414 miles ditto ditto, including taking up and relaying pavement, at £2,050 per mile		11,100
1 mile of ditto ditto, single track, Beckett-street and Burmantofts-street, at £1,500		1,500
77 cars with electric motors, complete, to carry 52 passengers, at £750		57,750
2,175-i.h.p. engines, boilers, dynamos, and fittings for 69 running motor cars, at 30 i.h.p., and 7 trailers, at 15 h.p., at £15		32,625
Buildings, sheds, offices, etc., for 2,175 i h.p., in one central station, at £6 (present sheds to be used for car storage)		13,050
3,000 yards of land for central station, at £2		6,000
		144,925
Cr. by six 'buses, at £20	£120	
Cr. by 62 cars, at £15	930	
Cr. by 380 horses, at £20	7,600	
Cr. by 380 sets of saddlery, provender, etc., at £2	760	
Cr. by 25 steam-engines, at £250	6,250	
		15,660
Total amount required for installing electric overhead system over and above first cost and cost of remodelling tramways		129,265
First cost and cost of remodelling present tramways, including buildings and equipment		249,234
Total first cost and cost of remodelling present tramways on electric overhead system, including buildings and equipment, up to 7½ minutes' service		£378,499

Collecting the three estimates:

The capital involved in remodelling the present tramways, and bringing them up to a 7½ minutes' service, on the present system is	£265,884
Ditto ditto, and in installing electric overhead system	378,499
Ditto ditto cable system	428,922

If the relative capital sum involved afforded a complete answer to the question of what our future system should be, clearly we should make no change, as the present system would involve the least capital. But it does not. The complete answer from the financial standpoint is not found in the system employing the smallest capital sum, but in the one which would involve the ratepayers in the smallest annual cost. The capital involved is in inverse ratio, though not uniformly so, to the annual cost. This un-uniform ratio of annual cost to capital involved, arises out of the fact that the works and plant on which the larger capital sums are expended are of varying degrees of permanence, and as such have to be repaid more or less rapidly than the system involving a smaller capital outlay. On the other hand, this larger expenditure on less permanent works often makes it possible to work at so much smaller a car mile cost as that it more than repays the increased annual liability arising from the larger capital account. In a word, a small capital expenditure means larger working expenses than the systems involving large capital expenditure.

Applying, therefore, this test as conclusive on the financial point, but premising that not only will the Corporation, like any private company, have to pay interest and provide a depreciation fund for renewals, or, what is the same thing renew out of revenue, but, in addition, the Corporation will have to repay the principal in a limited number of years, and that the two payments together will be, though not much more, still slightly more than a private company would have to pay who distributed amongst its shareholders a 5 per cent dividend. With this premise, I find the annual cost to the ratepayers of the present, the cable, and the electric overhead systems of haulage will be as follows:

Annual cost of working the Leeds tramways on the present system, with lines remodelled as before described, and with the additional rolling stock, etc., for a 7½ minutes' service in the outskirts, and a 3¾ and 1⅞ minutes' service in centre of city:

	£	£
Interest and sinking fund at 3 per cent., and repayment of capital in lines, buildings, and land, in 30 years—*i.e.*, 5·1 per cent. on	216,236 =	11,028
Ditto, ditto, at 3 per cent. and 20 years—*i.e.*, 6·75 per cent. (for horses, machinery, rolling-stock, etc.), on	49,648 =	3,351
	£265,884	
Renewing 35 miles of single track of tramway at £3,093 per mile amounts to £108,255. To raise this sum in 30 years by equal annual payments invested at 3 per cent. interest requires		2,275
Renewing rolling stock in 20 years by equal annual payments at 3 per cent. interest:		
25 engines at £800	£20,000	
25 bogie cars at £200	5,000	
59 horse cars at £150	8,850	
	£33,850	1,260
Expenses working 22 steam cars, running 18 hours per day, at 7½ minutes' interval, and nine hours on Sundays = 774,490 steam car miles at 10½d.		33,884
Expenses working 47 horse cars, as per steam working = 1,654,594 car miles at 9½d.		65,494
Present system total annual cost		£117,292

Annual cost of working the Leeds tramways on the cable system, with lines remodelled as before described, and with rolling-stock, etc, for a 7½ minutes' service in the outskirts, and 3¾ and 1⅞ minutes' service in the centre of city:

	£	£
Interest and sinking fund at 3 per cent., and repayment of capital in lines, buildings, and land in 30 years—*i.e.*, 5·1 per cent on	361,644 =	18,443
Ditto, ditto at 3 per cent. and 20 years—*i.e.*, 6·75 per cent. on machinery, rolling-stock, etc., on	67,278 =	4,541
	£428,922	
Renewing 35 miles of single track of tramway and slot rails to conduit, at £4,293 per mile, amounts to £150,255. To raise this sum in 30 years, by equal annual payments, invested at 3 per cent. interest, requires		3,158
Renewing rolling-stock in 20 years, invested at 3 per cent. interest, on		
84 gripper cars, at £250	£21,000	
Machinery, etc.	27,450	
	£48,450 =	1,803
Expenses working 69 gripper cars, running 18 hours per day and nine hours on Sundays, at 7½ minutes' interval = 1,198,336 car miles, at 8·37d.	41,792	
Ditto, ditto, at 3¾ minutes' interval = 787,890 car miles, at 6·58d.	21,601	
Ditto, ditto, at 1⅞ minutes' interval = 442,858 car miles, at 5·68d.	10,481	
		73,874
Cable system, total annual cost..		£101,819

Annual cost of working the Leeds tramway on the electric overhead system, with lines remodelled as before described, and with rolling-stock, etc., for a 7½ minutes' service in the outskirts, and a 3¾ and 1⅞ minutes' service in centre of city:

	£	£
Interest and sinking fund at 3 per cent., and repayment of capital on lines, buildings, and land, in 30 years—*i.e.*, 5·1 per cent., on	228,086 =	11,632
Ditto, ditto, at 3 per cent. and 20 years—*i.e.*, 6·75 per cent. (for machinery, rolling-stock, etc.), on	92,663 =	6,255
Ditto, ditto, at 3 per cent. and 10 years—*i.e.*, 11·725 per cent. (for motor cars)	57,750 =	6,771
	£378,499	
Renewing machinery and electric construction under and over road in 20 years, invested at 3 per cent. interest, on	92,663 =	3,448

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Renewing 35 miles of single track of tramway, at £3,093 per mile, amounts to £108,255. To raise this sum in 30 years by equal annual payments, invested at 3 per cent. interest, requires		2,275
Renewing motor cars in (average of machinery and car) 10 years, invested at 3 per cent. interest, on	57,750 =	5,037
Expenses working 69 motor cars running 18 hours per day, at 7½ minutes' interval, and nine hours on Sundays, equal 2,429,084 motor car miles, at 5·4d.		54,654
Electric overhead system total annual cost		£90,072

Summing up these estimates, and referring to my previous statement that the relation between the capital and annual cost was not uniform, the fact is here borne out as follows—viz.:

	Estimated capital account.	Estimated annual cost.
Present system	£265,884	£117,222
Electric ,,	378,499	90,072
Cable ,,	428,922	101,819

The difference in favour of the electric overhead system over the cable system is therefore £50,423 on capital account, and £11,747 in annual cost. As the number of cars and service in each of the systems would be alike, the income on each of the systems would be exactly the same; therefore no reference to that side of the account need be here made. So much for the comparison of the available systems financially. Comparing the systems in other respects, I take it without saying that the cable system, costing less than the present system, must be preferred to that system. But what about the electric overhead? Has the cable advantages over it, and, if so, are they so great as will warrant the cable's extra cost?

The advantages of the cable system over the electric are: No unsightly poles, overhead cross wires, or trolley wire along the whole length of each track. No sparking at trolley or car wheels to frighten horses. Less wear of metals, the road being less, and a rolling load, as compared with the grinding load of the electric car. More silent on the road, no buzzing of motors or rattle of gearing. No danger from falling overhead wires. A very large number of extra cars can be put upon a route to meet an emergency at a very slight increase of cost.

The advantages of electric over cable are: no central slot to catch horses' shoes or bicycle wheels, and only two rails instead of three for wheels to skid against. All power generated at the electric station is utilised, whereas by cable three-fourths of the total power generated is used in hauling the cable, however few the number of cars running may be. Electric cars may be run at varying speeds, and so make up for any loss of time, but not so the cable. The cable mode of construction involves repairs and interference with the traffic of the streets, which is not the case in electric. Electric cars can accommodate themselves to street traffic, whilst cable cars cannot, as their speed is regulated by the cable, and they cannot move backwards. A broken or blocked cable stops the whole route, both up and down, and the cars have to be hauled by some supplementary power off the streets, and the cable service on the route, up and down, is suspended until repaired, which must be a considerable length of time, whereas a breakage in the electric wire is purely local; and as the motor cars can move either backwards or forwards, the service can be continued by using the opposite track for both traffics or changing cars at the point of fracture. Less likelihood of traffic being stopped for renewing of wire leads than of cables; no new wires have yet had to be fixed in Roundhay-road, though they have been up three years, whereas cables have to be renewed every year, though by careful daily examination this is often done in the night. Brake power failing on a decline, control is maintained over the electric car by reversing the motor; cable cars cannot reverse, but must go with cable or run away. Cars lit by electricity are far more comfortable and convenient for passengers. In case of being superseded by another system, the materials and work totally lost would be much less in the electric system compared with the cable system. The electric overhead system has a greater field of improvement open to it in regard to cost than the cable system has.

Whilst it is true that the cable cars at a certain frequency of service beat the electric overhead in point of cost, excepting in towns having more severe gradients and a longer length of them than there are in Leeds, this feature has been greatly exaggerated. I find that the frequency required must be less than 1⅓ minutes' service, but it should be remembered, to be complete in this respect, that service must extend over the whole tramway system, or the cable system of the city fails. Such a service, of course, is out of the question. For instance, supposing Briggate and North-street, Boar-lane, Wellington-street, and Woodhouse-lane to Hyde Park Corner were on such a service as would give the advantage to the cable, say, a one minutes' service, the cable system for the whole undertaking of Leeds would then have only 6½ miles of paying line to meet the losses on 28½ miles in the remaining—*i.e.*, the slower part of the system.

It has been suggested to me—and until going into the figures I thought such an arrangement might be feasible—that the centre of the city should be worked by cable system and the outskirts by electricity, but from the figures I have already given it will be seen that the cable system, with its necessarily quick service, and the traffic needful to warrant such service, would be so limited in length as to render such a suggestion not practicable.

Comparing the advantages of the two systems, even ignoring finance, it appears, putting it broadly, that if it were not for the objectionable appearance which the poles and wires of the electric overhead system lends to the streets, and the weight of the car, that system would be practically, in all respects, superior to the cable. In regard to the weight of the car, it is only 6½ tons, and not 9½ tons, as is generally stated, and the weight of those now being made is only five tons, whilst the weight of the present bogie cars drawn by steam-engines is 4½ tons, thus leaving little to be complained of in this respect. As to the poles and wires, a great improvement can be made in regard to them also. All the wires running along the footpath should be laid underground, and all the poles placed against the buildings, or, when the width of the streets will permit, ornamental posts, carrying arc lights, should be placed in their stead in the centre of the roadway. With these improvements, and remembering that electric traction has a wider field for improvement than cable, I am of opinion that the electric overhead system of tramway haulage is certainly to-day, and more certainly for the future, the cheapest and best system for the city of Leeds.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Paris.—The Direction Générale des Postes et Télégraphes, rue de Grenelle, 103, Paris, invites tenders by July 6 for the supply of electric cables in two lots.

Manchester.—The directors of the Manchester Ship Canal Company invite tenders by July 10 for the permanent electric lighting of the Manchester and Salford Docks. All particulars will be found in our advertisement columns.

Portsmouth.—The Corporation of Portsmouth invite tenders by July 10 for conduits and indiarubber-covered electric mains and for "compound" covered electric mains. Further particulars are given in an advertisement in another column.

Bristol.—The Committee of Visitors of the Bristol Lunatic Asylum, Fishponds, invite tenders by July 15 for supply and fixing the necessary wires, lamps, etc., for lighting the asylum by electricity. Further particulars are given in our advertisement columns.

Clevedon (Somerset).—Tenders are invited for the public lighting of their district every night in the year from sunset till midnight, for the Urban District Council. Tenders to be for one, two, or three years, and to be sent to Mr. Hy. C. Fry, clerk, Clevedon, by July 1.

Motherwell (Scotland).—Tenders are invited by the District Committee of the Lanark County Council for the electric lighting of the new hospital being erected near Motherwell. Copy specifications and plans may be seen at the office of Mr. Alexander Cullen, architect, Motherwell. Sealed tenders, marked "Tender for Electric Light," to be lodged with Mr. J. F. Mackenzie, district clerk, County Buildings, Hamilton, by July 1.

Blackburn.—The Corporation of Blackburn invite tenders for the wiring of the town hall. Copies of the specification may be obtained from the engineer, Mr. E. M. Lacey, of 19, Old Queen-street, S.W., on payment of £1. 1s., which will be refunded on return of same accompanied by a bona fide tender. Plans may be seen at the office of the town clerk, or the engineer, from whom any further information can be obtained. Tenders must be sent in by July 13.

Preston.—Tenders are invited for the wiring and fittings required for the lighting by electricity of the Town Hall and public hall buildings. Specifications and conditions at the borough engineer's office, Town Hall, Preston, on payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Separate sealed tenders for each of the buildings must be sent to Mr. Henry Hamer, town clerk, Town Hall, Preston, endorsed "Tenders for Electric Lighting," by 12 noon on July 1.

Dewsbury.—Tenders are invited for the wiring of their premises, for the Committee of the Dewsbury Pioneers' Industrial Co-operative Society, Limited. Copies of the specification may be obtained from the borough electrical engineer, Mr. J. B. Mitchell, Electricity Offices, Bradford-road, on payment of 10s. 6d., which will be refunded on return of same, accompanied by a bona fide tender. Plans may be seen at the office of the borough electrical engineer Bradford-road, from whom any further information can be obtained. Sealed tenders, endorsed "Electric Lighting," must be sent to Mr. J. B. Mitchell, borough electrical engineer, Electricity Offices Bradford-road, by July 8.

Bradford.—Tenders are invited for the supply of best gas coal, cobbles, nuts, and cannel, all to be well screened, dressed, and free from shale and pyrites, to be delivered at the several works of the Corporation in the borough during one year or two years, commencing August 1, for the Gas and Electricity Supply Committee. Form of tender, with any further information required, may be had on application to Mr. Wood, gas engineer, Town Hall. Sealed tenders, endorsed "Tender for Coal," to be sent to Mr. W. T. McGowen, town clerk, Town Hall, Bradford, by July 3. An assurance must be given by each contractor that he pays to the workmen employed by him not less than the minimum standard rate of wages.

St. Helens.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of the following plant: Section A—boiler-house plant, including

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boilers and fittings, forced-draught apparatus, feed pumps, etc.; Section B—engine-house plant, including steam alternators, oil-filter, fittings, etc., steam, exhaust, feed, blow-off, and sundry pipes, valves, and water-tanks, etc.; Section C—main switch-board and instruments; Section D—underground work, including cables, junction-boxes, culverts, and trenching; Section E—transformers and fittings; Section F—meters; Section G—overhead crane. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. The ground plan of plant, plan of streets, etc., and specification, with terms and conditions of tender and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on and after June 11, on payment of £2 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed, and marked "Tender for Electric Lighting," must be addressed to the town clerk at the Town Hall, St. Helens, and be delivered on or before Tuesday, July 2.

RESULTS OF TENDERS.

Cardiff.—The Corporation have accepted the tender of the British Coal Company for the supply of coal to their electric lighting station at the price of 8s. per ton.

Manchester.—The following tenders have been accepted by the City Council: for the supply of five Lancashire boilers, Messrs. Heaton and Son, £5,371; for the supply of eight dynamo-electric machines, Electric Lighting Construction Company, £7,381; for supply of eight pairs of condensing engines, Mr. B. Goodfellow, £12,440.

Chester.—The following tenders have been received by the City Council for the supply of the electric light:

Alternating current.

Fowler and Co.	£14,893
Siemens and Co.	14,800
Manchester Edison-Swan Company	12,446
Electric Construction Company	11,755
Brush Company (street lighting not included)	8,922

Continuous current.

Electric Construction Company	£14,847
T. Parker, Limited (accepted)	14,200

Cardiff.—Tenders for the electric lighting of Messrs. Hancock's Brewery in Penarth-road have been received as follows:

Fergus and Co., Cardiff	£1,245	0	0
Clay Bros. and Co. (accepted)	1,337	17	0
Strode and Co., London	1,387	0	0
Saunders and Co., Cardiff	1,420	0	0
Knapman, Hodder and Co., Cardiff	1,420	6	0
Lewis and Fletcher, Cardiff	1,477	0	0
Laing, Wharton, and Down	1,572	10	0
Wilson, Aberdare	1,578	19	0
Easton and Anderson	1,579	15	0
Barclay, London	1,640	0	0
Clarke, Chapman, and Co.	1,705	0	0

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,436.

Keyham.—At Keyham Dockyard the local officials have received authority to obtain a steam dynamo at a cost of £700.

Folkestone.—At the last meeting of the Town Council it was arranged to discuss the subject of the electric light at a special meeting.

Derry.—The engineer to the Corporation has been instructed to prepare an estimate of the cost of the proposed electric lighting of the city.

Sleaford.—A suggestion has been made that the water power of the River Slea might be used in connection with an electric lighting scheme for Sleaford.

Mile End.—The Board of Guardians have held a meeting, at which a report on the proposal to light the workhouse by electricity was referred back to the committee.

Cardiff.—Messrs. Clay Bros. are just completing the wiring of the new buildings of the *Western Mail*, where there are nearly 500 lights to be supplied from the town mains.

Bray.—A suggestion from Mr. Fraser, C.E., with reference to the construction of an electric tramway from the railway station at Bray to the summit of the hill has been favourably received.

Burnley.—Mr. Bird Clerke has held a Local Government Board enquiry into the application of the Corporation to borrow £3,000 for extending the electric lighting plant and £2,500 for new mains.

Bell Push.—We have received from Messrs. George Wingrove and Son, 60, Queen Victoria-street, E.C., a circular of Dale's "bayonet joint" electric bell push. They are making it in four patterns.

City of London Electric Lighting Company, Limited.—The transfer books of the 5 per cent. debenture stock will be closed till the 30th inst. for the purpose of preparing the interest warrants.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 23rd inst. amounted to £1,245, as compared with £820 in the corresponding week of last year, being an increase of £425.

Hanover-square, W.—A new public library has been built by the St. George's, Hanover-square, Vestry in Chapel-place North, South Audley-street. It is lighted throughout by electricity.

Glasgow.—It is stated that the North British Railway Company contemplate abandoning the electric lighting system at present used on the Glasgow underground railway. The system in use is known as the fixed rail.

Exhall.—The Parish Council have received a letter from the General Traction Company, Limited, asking permission to use the material of the Westinghouse Electrical Company. It was agreed that permission be given.

Beaman and Deas Syndicate, Limited.—This Company has been registered, with a capital of £30,000, to acquire from J. Beaman and James Deas, of Warrington, Lancashire, certain patents relating to improvements in destructor furnaces.

Barnet.—On the motion of Mr. James, the Urban District Council have resolved to apply forthwith to the Board of Trade for an extension of the electric lighting provisional order obtained in 1893. The application, the mover said, would not incur any expense.

Kingstown.—The Town Commissioners have decided to approve of the application of the Electricity Supply Corporation of Ireland, Limited, to the Board of Trade for a provisional order to supply electricity within the township for public and private purposes.

Change of Address.—Owing to expiration of lease, Mr. J. C. R. Okes, engineer, of 39, Queen Victoria-street, is removing from that address to larger and more convenient offices and stores at Ormond House, 63, Queen Victoria-street, E.C., where his business is now being conducted.

City and South London Railway.—The returns for the week ended June 23 were £794, compared with £863 for the corresponding period of 1894, being a decrease of £69. The total receipts for the current period of the present half-year are £23,093 against £22,618 in the corresponding period of 1894, an increase of £475.

New Agency.—Messrs. Francis and Spilsbury, electrical suppliers and agents, of Mansion House-chambers, 20, Bucklersbury, London, E.C., have been appointed sole agents for the sale of Messrs. J. H. Tucker and Co.'s crank switches in Ireland, and the East, South, and West of England. Mr. Baker (Messrs. J. H. Tucker and Co.'s present London representative) still retains his agency for London only.

County of London and Brush Provincial Electric Lighting Company, Limited.—The directors have declared an interim dividend for the half-year on the preference shares at the rate of 6 per cent. per annum calculated from the due date of payment on the £2 per share paid up, and payable to all registered shareholders on the books of the Company at June 30, 1895. The transfer books will be closed from July 1 to July 14 inclusive.

Aberystwith.—A meeting of the Town Council has been held, at which a communication was read from Mr. Aslett, secretary of the Cambrian Railways Company, expressing the disappointment of his directors that no electric lamp had been placed by the railway station. The matter was referred to the Public Lights Committee. On the motion of Alderman C. M. Williams, it was decided to refer Mr. Preece's report on the electric light to the Public Lights Committee.

Liverpool.—Petitions have been deposited in the Private Bill Office of the House of Lords by the Liverpool Electric Supply Company, Limited, and by the Corporation of Liverpool, for leave to introduce a Bill this session to authorise the transfer of the undertaking of the company to the Corporation. The petition came before the Examiner of Private Bills in the House of Lords on Tuesday. It was decided to report that the petition had failed to comply with the Standing Orders.

Eastern Extension Telegraph Company.—The directors have declared an interim dividend for the quarter ended March 31 last of 2s. 6d. per share, free of income tax, payable on July 15. The share register will be closed from July 6 to July 13, both days inclusive. The coupon on the company's 5 per cent. Australian Government subsidy debentures due July 1 will be paid, on and after that date, at Messrs. Barclay, Bevan, and Co.'s Bank, 54, Lombard-street, London, E.C. Coupons must be left three clear days for examination.

London, W.C.—We understand that Messrs. Vaughan and Brown, Limited, have just completed the installation of Romano's, in the Strand, which since its rebuilding is one of the handsomest restaurants in London. In addition to the electric lighting, they have executed the whole of the ventilation by means of electric fans, together with the gas lighting electric bells, despatch and speaking tubes, under the direction of Mr. W. Emden, architect. The above firm have also just completed a large installation of about 1,200 lights at the North-Western Fever Hospital, Hampstead, under the direction of Prof. Ayrton, also the whole of the electric bells, telephones, speaking-tubes, and gas lighting throughout the building.

Bath.—The electric light company's employés had an outing last week, and were accompanied by Mr. G. F. Metzger (engineer and manager) and Mr. W. Jeffery (secretary). A start was made in brakes about eight o'clock, the drive *vid* Farmborough, Marksbury, and Chewton, where horses were changed, being very enjoyable. A luncheon was served at the Cliff Hotel, and during the afternoon the party viewed the caves. Tea was partaken of at five o'clock, and before dispersing Mr. C. Cornelius proposed a vote of thanks to Mr. Metzger, which was supported by Mr. Jeffery. Mr. Metzger responded, and was heartily cheered. On

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the return journey a halt was made at Chewton, where dancing was indulged in, and songs were rendered by some of the company. Bath was reached about 11 o'clock.

Bristol.—The Sanitary Committee have held a meeting, at which a letter was read from Mr. W. A. Todd, who was unavoidably absent, asking the committee to consent to a proposal of the tramways company which, whilst giving two extra electric lamps in Old Market-street, would reduce the number of standards from 15 to 10, and the additional cost to the city would be only £25. The Vice-Chairman said he thought Mr. Todd had been misinformed. The cost would be £25 per annum per lamp. After a debate on the extra two lamps for Old Market-street, the question was ultimately referred to the Electrical Committee, several members protesting against the extra cost, stating that if extra lamps were to be provided anywhere, Bristol Bridge and other thoroughfares named should be favoured.

Appointments Vacant.—The governors of the Northern Polytechnic require applications for the appointment of principal. After March 25, 1896, the stipend will be at the rate of £500 per annum, and the principal will be required to devote his whole time to the work of the institute. From September 29, 1895, till March 25, 1896, the stipend will be at the rate of £300 per annum, and the principal will be required to attend the governors' meetings, to take supervision of the equipment of the institute, and to make arrangements for the future educational work. Applications must be made on or before July 15 on forms which, together with particulars of the duties of the office, can be obtained of Mr. E. Griffiths secretary, St. Mary's Vestry Hall, Islington, N.—The House-to-House Electric Lighting Company, Earl's Court, want a fitter.

Croydon.—Major-General C. Phipps Carey, R.E., has held an enquiry on behalf of the Local Government Board, at the Municipal Offices, Park-street, into the application of the County Council for sanction to borrow £27,000 for electric lighting purposes. The town clerk (Mr. C. M. Elborough) appeared for the Corporation. Mr. Alderman Miller, J.P., the chairman of the Electric Lighting Sub-Committee, stated that he was of opinion, from personal enquiries, that the electric light was much desired in the borough. The Corporation were erecting a new town hall and other public buildings and would be large consumers of the light. The Inspector said he thought the Local Government Board would require more details, and pointed out that no plans had been put in with regard to the proposed buildings. The Town Clerk said Prof. Kennedy would undertake to supply the plans in a fortnight, and the enquiry closed, the inspector promising to report in due course.

Fort William.—A meeting of gentlemen interested in the promotion of an electric light scheme for the burgh of Fort William and district has been held in the Town Hall there. Mr. Yorke, electrical engineer, was present, and explained the proposed method of working. The matter has been very heartily taken up, and a company is now being formed to carry out the scheme. Mrs. Cameron Campbell, the proprietress of the ground on the west side of the River Nevis, from which stream the motive power is to be obtained, is to give the land through which the water is taken, and the use of the water itself free. Negotiations are proceeding with Lord Abinger, on whose ground the turbine-house will be erected, who is also interested in the water, and it is hoped similar favourable terms will be arranged with him. It may be mentioned that the late Lord Abinger supported a similar electrical scheme, and it is anticipated that the present Lord Abinger will also be favourable to the project.

Private Bill Legislation.—Before Lord Camperdown's Committee, the Strand electric lighting order raised a controversy between the Charing Cross and Strand Electric Company, who are the promoters of the order, and the Metropolitan Electric Supply Company. The former company represent the principle of the direct continuous current, and the latter the alternating high-tension system. Mr. W. T. Madge, of the *Globe* and the *People*, spoke highly of the former system for driving the Linotype composing machines, and Mr. Vesey, consulting electrical engineer to the *Graphic*, *Daily Graphic*, *Illustrated London News*, *Tit Bits*, and other papers, also expressed his preference for the direct continuous system for newspaper machinery. The committee adjourned, and on Tuesday the committee heard further evidence as to the relative merits of the methods employed by the Charing Cross and Metropolitan Electric Companies, the latter being supported by Lord Kelvin and Mr. Ferranti. The committee passed the order giving powers to the Charing Cross Company.

Manchester Suburban Electric Supply, Limited. — The prospectus of this undertaking has been issued. The subscription lists will close on Saturday, the 29th inst. The share capital is £25,000, divided into 3,000 6 per cent. preference shares of £1 each, and 22,000 ordinary shares of £1 each, half of which are now offered for subscription. The directors comprise Mr. Charles Hunter (chairman), Mr. James Nuttall, Mr. Joseph Nasmith, Mr. Thomas Parker, and Mr. E. Jessie Piper. The offices are at 8, South King-street, Manchester. The district proposed to be dealt with in the first instance is that of Moss Side, and favourable arrangements have been made for the acquisition of a plot of land for the erection of a generating station. The directors in the first instance propose to put down a plant and mains sufficient to light the district, including Whalley Range, and Moss-lane East and West, from the District Council offices to the Whalley Hotel, and along the Alexandra-road to Yarburgh-street, but as the demand for current increases in the rest of the district it is proposed to lay down mains in the whole area covered by the order. Already applications have been made for current sufficient for 2,250 lamps, and the forward prospects are decidedly good. The promoters state that from "the returns of other companies it is safe to estimate that the revenue from these applications should be at least £1,000 per annum, and the working expenses for the first year should not exceed £600, so that there is every probability of the undertaking being supported and paying its way the first year, while all increase of custom will add to the profits of the company.'

Electric Organ Company, Limited.—The Electric Organ Company, Limited (Hope-Jones system), has been formed, with a capital of £110,000, divided into 55,000 £6 per cent. cumulative preference and 55,000 ordinary £1 shares, for the purpose of acquiring and carrying on upon an extended sale the business of the Hope-Jones Electric Organ Company, Limited, and to take over the patents, plant, and other property now held by that concern, and certain further patent rights more recently applied for by Mr. Hope Jones relating to improvements in organs and new methods of producing organ tone. It is also proposed to secure the Hope-Jones electric organ patents for France, Belgium, Germany, Austria, and Hungary, including the benefit of a license granted to Messrs. François Mader et Cie. for certain rights in the French patents for which they agree to pay a royalty, and the right to all further improvements in organs and organ building which Mr. Hope-Jones may invent during his engagement with the Company, including the right to adapt his inventions to harmoniums, American organs, etc. The Hope-Jones Company was formed in 1892 with a capital sufficient to test and introduce Mr. Hope-Jones's improvements in the application of electricity to organs. The purchase price has been fixed at £29,348, of which the vendors have agreed to take £17,340 in the form of a deferred interest in the future profits, by the issue to them of ordinary shares as fully paid up, and £12,008 in cash. The public were invited to subscribe for the whole of the preference and for 37,660 ordinary shares, the list closing at the beginning of this week.

York.—The City Council on Tuesday night further considered a report of the Electric Lighting Committee recommending the acceptance of the tender of the Electric Construction Company, of Wolverhampton, to supply the necessary plant and fittings for the sum of £10,865, and application for sanction to borrow £15,000 for the purpose. The scheme proposed is know as the Oxford system. There were three other tenders as follows: Siemens Bros. and Co, £10,345; Brush Electrical Engineering Company, £8,360; C. A. Parsons and Co., £10,266. Alderman Agar moved, and Mr. Mann seconded, the adoption of the report. Alderman Wragge spoke against the motion on account of the costliness of the scheme, and moved an amendment that the tender of the Brush Company be accepted, with a provision for the working of the plant by them for a term of years, subject to a modification of the terms proposed. The amendment was seconded by Alderman Coning, and after some discussion it was out to the meeting, when the voting was—for the amendment 4, against 10, neutral 12. The amendment was therefore lost. Mr. Purnell spoke at considerable length, comparing the various schemes, and concluded by moving that the tender of C. A. Parsons and Co. be accepted. Mr. Anderson seconded, but the amendment was rejected, only six voting for and 13 against. Further discussion ensued, after which Alderman Coning moved that the report of the Electric Lighting Committee be referred back with instructions to ascertain from the four companies on what terms they will supply the city and work the plant for a term of years. Alderman Wragge seconded, and it was carried, after which the Council adjourned.

Edinburgh.—A meeting of the Town Council has been held, at which it was recommended by the Lord Provost's Committee to extend the high-tension electric light mains to the district of Regent, Carlton, and Royal terraces, to South Back Canongate, to George-square, and to the south side of the city, at a probable cost of about £5,000. It was explained by Councillor Mackenzie that the committee proposed to lay a ring main to the south side by Princes-street, George-square, The Grange, and Morningside, in order to carry the high-tension current, without which those places could not be supplied with the incandescent light. Mr. Cranston asked if the committee had received the necessary guarantee, and Mr. Mackenzie said that from the people in the terraces they had more than the necessary guarantee, and in Clerk-street and George-square they had the same, but they could not give the supply without the high-tension main. The question was, therefore, whether it was desirable to put in this ring main or simply to make some temporary attempt which would subsequently have to be thrown overboard. They considered the electric light was a success, and that the proper thing to do was to put in this ring main at once. Mr. Cranston moved that sanction be delayed until the guarantee was obtained, and Mr. John Jamieson seconded. After some further conversation, however, Mr. Cranston withdrew his motion, and the report of the committee was adopted. Mr. Mackenzie and Sir James Russell were afterwards appointed to attend in London in the matter of the regulations and conditions proposed to be made by the Board of Trade in the interest of public safety in connection with the installation of the electric light.

Central London Railway.—The directors of the Central London Railway Company have announced the issue of 285,000 £10 shares, the subscription list for which was opened on Monday last and closed on Wednesday. The Company was incorporated in 1891, and obtained further powers in 1892 and 1894. The share capital consists of £2,850,000, and the borrowing privileges extend to £950,000. The line is to be about 6½ miles long, and will run between Shepherd's Bush and Liverpool-street, under Uxbridge-road, Bayswater-road, Oxford-street, High Holborn, Holborn Viaduct, Newgate-street, Cheapside, Poultry, and Old Broad-

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street. The motive power will be electricity. A contract has been entered into with the Electric Traction Company for the acquisition of the necessary land and the construction and equipment of the railway with all its appurtenances for the lump sum of £3,244.000, payable as to £2,544,000 in cash and £700,000 in debenture stock bearing 4 per cent. interest. The contractors undertake all risks and contingencies of every kind in connection with the construction of the line and works, which are to be handed over complete and in working order ready to be opened for public traffic by December 31, 1898. From estimates made by the engineers it appears that the total working expenses with an electric 2½-minute train service may as a maximum be taken at £152,000 a year. Calculating on an average receipt of 2d. per passenger, and the expenses as mentioned, the anticipated annual traffic, taken at 7,000,000 passengers per mile, would, it is stated, yield sufficient net receipts to pay 4 per cent. on the debenture stock and 5 per cent. on the share capital, with a margin of over 1 per cent. on the latter for contingencies.

New Government House, Rangoon.—The whole of the electric light installation for this magnificent new building has been supplied to the order of H.M. India Office by Messrs. Henry F. Joel and Co., of Wilson-street, Finsbury-square, London, under the supervision of Mr. W. H. Preece, F.R.S., and consists of two Joel patent dynamos, each capable of lighting 250 lamps, together with main switchboards and distribution switch and fuse boards, all fitted in polished teak cases and specially constructed to withstand the heat and moisture of the climate. There are nearly 400 lamps fitted, of which 11 are of 200 c.p. The lamp fittings are designed to agree with the beautiful decorative architecture. Full details and carefully-made plans and descriptions were sent by Messrs. Joel and Co. with the materials to facilitate the erection of the plant. The two engines and two boilers were supplied by Messrs. Davey, Paxman, and Co., of Colchester. The engineer in charge at Rangoon officially reported that the quality of the materials was of the highest character. The following is taken from the *Rangoon Times* of May 10, 1895: "A trial of the electric light took place at the new Government House last night, and proved most successful. Lady Fryer, Mr. Hoyne Fox, and Mr. MacDonald (superintending engineer of the I.F. Company) were present, and a few others close by had a peep. The whole house was a mass of light. The two magnificent lamps in the portico were a grand sight. All the other lamps of varying sizes with good opal shades were also very effective. Great credit is due to the I.F. Company for the erection of the lights. There was not a hitch. Mr. King, the engineer, who was in charge of the erection of the wire, lamps, etc., had to undergo a great deal of inconvenience when running the wires, while other works were being carried out."

Interior Conduit System.—We have received from the General Electric Company, Limited, 69, Queen Victoria-street, E.C., a circular descriptive of their "interior conduit" system of electric wiring. This system is one in which a highly insulating, waterproof, and practically fireproof tube or conduit replaces wood casing. It is admitted that wood casings have many disadvantages, amongst which may be enumerated unsightliness, unnecessary cost of labour in erection, etc., and share in common with ordinary metal pipes the want of mechanical and electrical properties which are essential to a safe and durable installation. "Concealed" or "plastered-in" electric wiring work is continually increasing, and it is recognised that the present system of wood casing and other methods must be gradually superseded by some system designed with a more exact knowledge of the conditions to be fulfilled. The firm's system of "insulating tubing" is presented in three grades—plain, brass-covered, and iron armoured—as satisfying all the conditions necessary to the erection of a perfect installation. Prominent among the advantages of this system may be mentioned the fact that the tubing can be installed with a saving of 30 per cent. to 40 per cent. in labour, as compared with wood casing, since all mitreing and screwing on of covers is avoided, all necessary bends, elbows, etc., being provided ready-made. The tubing having once been installed throughout a building, the wires can be drawn in or out whenever required with a minimum of inconvenience and cutting away. It can safely be embedded in plaster, in the same way as speaking-tubes or gas and water pipes, thus admitting the planning of a complete and comprehensive system of conduits in which the wires are always accessible. When using tubing, it will be found most convenient to adhere to the "centre of distribution" method of installation, so that all fuses are grouped together in convenient positions. From these "centres" tubes can be led off to the points in service.

Bangor (Wales).—The question now before the City Council of introducing the electric light into Bangor has created a great deal of interest amongst the inhabitants of the city, says a local paper. It was expected that the report of Mr. Medhurst (the consulting engineer appointed by the Council to aid them in this matter) would be to hand soon, when it would be fully discussed by the Electric Light Committee of the Council. Much hope is entertained that the report will be a favourable one, inasmuch as the setting up of an electric light installation would undoubtedly enhance the value of Bangor both as a place of residence and a resort for visitors during the summer months. Considerable doubt seems to pervade the minds of some of the inhabitants as to the manner in which the electric light and the present gasworks could be carried on together without any detriment to the latter. It is certain that a large sum of money must be spent upon the gasworks immediately, unless something else is done, in order to meet the increasing demand for gas, and also to supply the large number of new houses which are in course of erection at present. Many members of the City Council are of opinion that this is a favourable opportunity for introducing the electric light to Bangor. If the same price is charged for the latter as for gas it cannot make any difference to the Council whether they put more capital into the present gasworks or expend such additional capital upon an electric light installation, provided the same profit can be made out of it. Judging from the experience gained in other towns and the dividends paid by various electric lighting companies, a much larger profit can be made by the supply of electric light than by the supply of gas. Several of the leading householders and tradesmen in Bangor have intimated their intention of taking up the electric light as soon as the necessary plant for its production may be laid down. It is further to be hoped that many householders who now do not use gas in their houses, as well as others, will come forward to assist the Electric Light Committee in carrying out this important proposal for the good of the community by having their houses and business premises wired for the electric light.

Brighton.—At a meeting of the Lighting Committee of the Town Council, held on 10th inst., tenders for the supply of coal to the electricity generating station during the year commencing July 1, 1895, were considered and it was resolved to accept the tender of Messrs. Banfield and Co. to supply Powell Duffryn (Fforchaman) at 19s 7d. per ton and Linby at 17s. 3d. per ton. A letter from Councillor Halliwell as to the lighting of Lewes-road, and suggesting that some of the Sugg lanterns proposed to be removed from the Marine-parade should be placed there, was referred to the borough surveyor to report upon. The letter from the town clerk of Hull, with reference to the regulations and conditions for securing the safety of the public proposed to be issued by the Board of Trade, and enquiring if the committee are prepared to assist in a joint representation being made to the Board, was again submitted. A further letter was submitted from the town clerk of Hull on the subject, and forwarding print of proposed draft regulations showing the clauses which, in the opinion of the Hull Electric Lighting Committee, require modifying, and inviting representatives of the committee to a conference at the Westminster Palace Hotel on the 11th inst. Letters from the manager on the subject of the proposed regulations were also read. It was resolved that the Mayor, the chairman, the town clerk, and the manager of the electricity works be requested to attend the conference. Councillor Stafford, in moving the confirmation of these proceedings at last week's meeting of the Town Council, explained that the committee accepted Messrs. Banfield and Co.'s tender for one class of coal at 17s. 3d., instead of that of Messrs. Rickett Smith, and Co. at 16s. 6d., because the application for tenders was for the two kinds of coal, and they could not divide them. Councillor Greenyer asked if, as they were laying a new cable in Edward-street, that was likely to produce any other business. It was a large amount to spend to supply one man. Councillor Stafford replied that the Lighting Committee never put down cables unless they were assured they would pay. The Lighting Committee submitted tenders they had received for the supply of 45 cast-iron upright posts with bracketed canopies, required for supporting electric light arc lamps. The committee recommended the acceptance of the tender of Messrs. Mackenzie Bros., of Edinburgh, for £1,530. On the motion of Councillor Stafford, this report was adopted.

Portsmouth.—The electric light in Portsmouth has just passed its first anniversary, says a local paper, and no commercial or municipal undertaking could have given more satisfactory results, thanks mainly to the indomitable perseverance of the chairman of the committee, Alderman G. Ellis, J.P. Wherever the mains have been laid tradesmen and residents have eagerly introduced the light into their establishments, and requests have come in from all sides urging the committee to extend. In fact, many tradesmen, while effecting alterations to their establishments, have had them wired, so as to be ready to use the electric light so soon as the cables pass through the street. It is to meet this general demand that extensions are about to be undertaken which will include all the main thoroughfares of the borough within the lighting district. At the present time the mains stop at All Saints' Church. They are now to be extended as far as the tramway stables at North End. Mains will be taken from Kingston Cross through Buckland and Fratton roads, Victoria roads (North and South), Marmion-road, and Kent-road, and joining the existing main at the Pier Hotel corner. From Portsea, the present Queen-street main will be extended up Edinburgh-road, and it will be carried from Commercial-road through Arundel-street and Fratton-street, along Fratton-road, through St. Mary's-road to the lunatic asylum Other mains will be taken up Lake-road and through Fawcett-road and along Albert-road, joining at the Victoria-road police station. Over this area there are to be 250 arc lamps for public lighting. At present there are 100 of these lamps in the borough. The advantage for street-lighting is immense, and although apparently more expensive than gas, yet, light for light, it is not one-tenth the cost. Each arc lamp will be of 12½ amperes power, equal to 2,500 c.p. whereas the ordinary five-light gas burners, with which most of the main roads are now lighted, do not range beyond 100 c.p.—most of them not more than 80. It was stated at the last meeting of the Council that the lunatic asylum was to introduce the light, and now, we understand, all the police stations are also to use it. All this public lighting, with the additional private lighting, will give a big revenue next year. Altogether, Alderman Ellis and his committee are to be congratulated on the first year's working, and on the leading position they have given Portsmouth among the cities and towns of the kingdom that use the electric light.

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Stoke-on-Trent.—The Town Council have held a meeting at which a sub committee of the Council who had met the chairman and electrical engineer of the North Staffordshire Tramways Company (Messrs. Carruthers-Wain and Sellon) on the subject of the proposal to work the tramways by electric traction by means of overhead wires, reported that in reply to a question as to whether it would not be possible to lay the wires underground, and so do away with the posts for overhead wires, which would have to be fixed 40 yards apart, Mr. Sellon said it would be absurd to contend that the underground or conduit system could not be adopted in the district, but there were at the same time many disadvantages. In the first place, the rain and damp would sink into the mains, flood the whole of the installation, and thus be the means of suspending the whole of the traffic from time to time; and in the second place, the extra cost per mile would amount to between £2,500 and £3,000, which in itself would make it impossible for the company to carry out the conduit system. The question of the double lines in Church-street was discussed, and Mr. Wain said he should prefer to leave that matter to the Board of Trade, and he would abide by its decision. He did not see, however, how they were to give a more frequent service without the second line to carry the traffic of the London-road section. The question of the extension of the tramways to Trent Vale was considered, and Mr. Wain stated that the company would immediately apply for a provisional order to extend the line to Hanford Bridge as desired, providing the Corporation gave its consent to their proposals. The sub-committee recommended that, subject to the whole of the local authorities in the district being of the same mind, and to satisfactory replies being received to enquiries to be made by the town clerk from places where overhead traction had been adopted, the Corporation should consent to the introduction of electrical traction by means of overhead wires, and subject to the company giving a satisfactory undertaking to apply for a provisional order to extend the present terminus in London-road to Hanford Bridge within a period of two years from the date of the granting of such order. With respect to the undertaking required by the company as to the Corporation not exercising their option of purchase under the provisions of the Tramways Act, 1870, at the end of 21 years, the committee recommended that the matter remain over for further consideration, to enable the Corporation to ascertain what such purchase would include. The report was adopted without discussion.

Cardiff.—A meeting of the Lighting and Electrical Committee of the Cardiff Corporation has been held under the presidency of the Mayor (Alderman Carey). A letter was read from Mr. J. Ballinger, chief librarian, directing the attention of the committee to the fact that a reduction or discount on the cost of supplying electric light to the free library had been promised to that institution. The letter pointed out that on the faith of that understanding the Free Library Committee had made arrangements for the electric lighting. A former letter to the same effect had been written by Mr. Ballinger, but to that communication the committee had replied that, seeing that all other departments of the Corporation were charged the full terms for electric lighting and no reduction had been allowed, the committee could not see its way to allow any discount to the free library. It was seen by reference to the minutes of the Lighting Committee of September 18, 1894, that an agreement was made therein for a substantial reduction being granted to the free library if a large quantity of electricity were consumed. It was agreed that the Library Committee be informed that this resolution would be adhered to, but the amount of the discount could not be estimated until the quantity of electricity consumed had been ascertained. A motion was made by the Mayor that for the benefit of those townspeople who were patrons of the Channel trips a Bray lamp be erected at the pier head, near the Windsor Hotel. The whole neighbourhood was at present only illuminated by one lamp. The borough engineer was instructed to report upon the matter. A long discussion took place as to how it came about that a pair of small engines at the Canton lighting station were not in use It was explained by Mr. Massey that the committee had altered its plans, and that the engines were required to do work that they had not been designed to perform. It was his opinion that the committee would never get the full amount of lighting until they ran the engines the whole 24 hours. It was also contended that the number of hands employed at the works—17—was very large, and that an unnecessarily large number of fitters were engaged. A letter to the Press from Mr. S F. Walker alleged that the pipes under the streets containing the service cables were, when recent excavations were made for gas and water mains, found to be seriously corroded in certain places. The Mayor regarded this as a very serious statement, and thought the committee ought to investigate it. It was arranged that Mr. Walker should be asked to indicate to the borough engineer the exact spot where the corrosion complained of was to be found. Mr. Good entered into a general criticism of the works in regard to both construction and management, and pronounced both most unsatisfactory. The *Western Mail* has interviewed Mr. Harpur, the borough engineer, who stated that satisfactory progress was being made with electric lighting in Cardiff. New premises were continually being wired, and fresh applications were almost daily received. There were now upwards of 60 consumers, and in several cases premises had already been wired where there were no Corporation mains, and in anticipation of the extensions proposed in Newport-road, as far as Castle-road, West-grove, up to the south end of Richmond-road and down Charles-street and Nelson terrace to the new baths, which are also to be lit by electricity. An application has been made to the Local Government Board for loans to the amount of £5,385 to carry out the extensions indicated.

Fulham.—The Vestry have held a meeting, at which Mr. Sayer had a motion on the agenda paper to take precedence of all other business, but as the member was not in attendance it was suggested that the matter should be withdrawn. Mr. Marks said it was usual for the Vestry to show courtesy to a member who was unable to attend the Vestry at the appointed time. He did not know why this courtesy should not be shown to Mr. Sayer. The Chairman explained that it was arranged to take the motion which had reference to the introduction of electric lighting in the parish at the commencement of the business. Mr. Lacey condemned the suggested scheme as the rates were already high enough, and the finances of the parish did not justify the Vestry in embarking on a heavy expenditure. He therefore moved that before instructing any electrical engineers to report upon the question of introducing the electric light into the parish, the parishioners be polled in a similar manner to that adopted in the case of the free public library. Mr. Perry seconded the proposition. The Chairman pointed out that they were altogether in the dark as to whether such a scheme could be worked with profit to the parish. He suggested that they should first consult an electrical engineer on the subject, and then the Vestry would be in a position to decide one way or the other. Mr. Marks concurred with the chairman, and said the proposed expenditure of £50 for expert evidence would be money well spent. They desired information on the subject, and if the Vestry now ran away from the idea they would be the laughing-stock of London. He ridiculed members running away from their previous opinions. The suggestion would only bind the Vestry to the preliminary expenses. Mr. O'Brien also thought that the expenditure of £50 would be money well spent. Mr. Green urged the Vestry to hesitate, because it would be a serious matter if after the introduction of electric lighting into the parish they found that it could not be supported. Mr. Lacey withdrew his motion, as the general opinion of the Vestry was in favour of obtaining expert information from an electrical engineer at a cost of £50. Mr. Thelwall then moved that the matter be referred back to the Electric Lighting Committee, with instructions to report as to the following points: (1) whether they consider that there is reasonable ground for supposing that electric lighting, in conjunction with a dust destructor, can be installed in the parish at a profit to the ratepayers, and without involving any addition to the rates; (2) in the event of the committee returning an affirmative answer, to state their reasons for the conclusion at which they have arrived, and select the names of three engineers or firms of engineers, of whom they recommend the Vestry to choose one, with a view to his being asked to report as to whether the suggested installation can be carried out in such a manner as to prove a source of profit to the parish. Mr. Marks said the last speaker forgot to mention that it was proposed to provide a dust destructor so that the two things could be worked together at a considerable saving to the rates. Mr. Thelwall's motion was carried, with the addition that the committee be empowered to spend £50 in obtaining the required information.

Southampton.—The Works Committee have reported to the Town Council that the sub-committee appointed to consider the question of the Board supplying their own electric power had again considered the report from Mr. Aldridge as to the proposed electric plant at the Town Quay. Mr. Aldridge therein adhered to his statement of cost of production (estimated at 3·90d. per unit), and also as to the capital outlay, with the exceptions as to the buildings and site. He discussed with the committee the suitability of several sites, and suggested the Board's yard as the most desirable. In conjunction with the surveyor, he estimated the cost of the proposed buildings at £1,200. The sub-committee unanimously resolved that, having carefully considered the reports from the electrical engineer showing that a current might be obtained at about 4d. per unit, as against 6d. now charged by the company, it appeared desirable that the Board should have an installation of their own, but before deciding definitely what should be done they thought it would be well to await the decision of the Corporation as to the purchase of the works of the company, in the event of which satisfactory terms might be arranged with the Corporation. The committee adopted the report of the sub-committee. Before the minutes were read, Mr. Emanuel objected to the chairman—as he was interested in the electric lighting company—presiding over the Board whilst the Works Committee's minutes affecting the electric lighting of the pier and harbour were under discussion, and moved a resolution to that effect. Alderman Cleveland thought it necessary that they should have the information the chairman could impart, and on the point of legality being raised, the clerk read the by-law affecting the matter. This showed that any interested commissioner could be present during proceedings, but was not competent to vote. Mr. Emanuel: I object to your presiding, Mr. Chairman. The chairman insisted that he was not disqualified from presiding, and took upon himself the responsibility of the course he adopted. Mr. Hogge seconded Mr. Emanuel's motion. Mr. Emanuel added that every gentleman, directly or indirectly interested, should take the course he had suggested, and take no part in the deliberations of the Board on the question of electric lighting. Alderman Cleveland did not think Mr. Emanuel should press his objection, as it seemed by the clause that the chairman was perfectly entitled to sit. Five voted against the proposition and three in favour of it, the remainder either being neutral or abstaining from voting. The chairman accordingly declared the motion lost. The minutes having been read, Mr. Gayton moved their reception. In doing so, he said he was placed in an invidious position by the absence of Alderman Bone. Mr. Scovell seconded. Mr. Emanuel said the matter had been a long time under discussion, and urged the necessity on the grounds of economy of the Board providing their own electric light. He pointed out that the supply at the free

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library had been very cheap and satisfactory, costing, as it did, 3¼d. per unit, including lamp renewals, etc., whilst the Board was paying 6d. per unit. He did not think they ought to wait for the Corporation. Even if that body did acquire the electric lighting works, they would have quite sufficient to do to supply the town. He had gathered that the amount paid for electric light in the months of March and April was £88. 7s. 6d., equal to £530 a year. He moved, as an amendment, that the Works Committee be instructed to at once take steps to provide their own electric light. Alderman Cleveland thought that with the possibility of a good customer like the Harbour Board the electric light company might get a better price for their undertaking from the Corporation. He did not see why the ratepayers should be called upon to pay more than they were actually worth. The amendment was put to the vote and carried by 13 votes to 1. The Chairman, after declaring the vote, said it might satisfy Mr. Emanuel when he told him that he was one of the first to propose that the Harbour Board should supply their own electric light. Mr. Emanuel said it was the principle of the thing he objected to The sub-committee of the Works Committee reported that, having considered the report of the wharfinger as to the supply of crane power at the quay extension, they recommended the Board to obtain estimates for three additional cranes—viz., one 12-tons and two 2 tons. The committee's recommendation was approved.

Bristol.—At a meeting of the Assessment Committee held at St. Peter's Hospital for the purpose of hearing appeals, the case of the rating of the city electrical station and general lighting service was taken. The assessment returned stood at £3,000 gross and £1,850 ratable value, otherwise net. Mr. Wise (from the town clerk's office) showed cause against the figures, and Mr. Parr (Osborne, Ward, Vassall, Parr, and Co.) supported the rating authority. Mr. Wise, who was heard first, said he should ask the committee to reduce the estimate for rating purposes to £1,745 gross and £1,428 net. He remarked that the account on which his figures were based showed that the number of private lamps fixed on December 31 was 15,000. He had estimated for an increase of about 2,300 for the present year, and the account he was presenting was therefore based upon the number of lamps being 17,425. They got an average revenue of 6s. 11½d. per lamp, which in the total he had given, would yield £6,062. 9s. 2d. Certain customers were allowed discounts varying, according to the amount of their bill, from 5 to 20 per cent., which worked out to an average reduction of 3 per cent., equal to £181. 7s. 5d., bringing the net revenue of private lamps down to £5,880. 11s. 7d. The next source of income to be dealt with was the quantity of electricity supplied to street lamps. This came to 150,417 units; the number of public lamps was 90, and these were charged at the same price as private consumers—namely, 6d., which equalled £3,760. 8s. 6d. The lighting authority was clearly entitled to be treated on the largest consumer basis, and so came in for 20 per cent. reduction, amounting in all to £752, which left the net revenue from street lamps at £3,008 and the gross from all sources £8,888. Next, they were confronted with the cost of production, which totalled up to £5,808, and subtracting this from the gross they had again the net at £3 008. Deducting therefrom tenants' share of revenue and landlords' deductions, the total was still further reduced to £2,061, from which had to come rates and taxes at 6s. 8d. in the pound, amounting to £516, which brought down the net annual value of the whole undertaking to £1,545. Inasmuch as the works were situated in two poor-law unions, with a gross of £676 outside that authority, this brought it down to £1,428, to which sum he asked the committee to reduce the assessment. Enquiries had been made in various quarters to ascertain the amount at which electric light stations were assessed, and in no case except Manchester did it approach to anything like the sum which was put down on the Bristol undertaking. In Manchester, where it was assessed at £2,500, there was a supply of 439,000 units as against Bristol's 293,000. The Board of Trade returns markedly corroborating what he had advanced, his committee thought that they were being unfairly dealt with and the sum which he had asked the authority to fix for the rating was a fair and reasonable one. Mr. Parr enquired the cost of the whole of the undertaking in Bristol, remarking that unless they knew that the comparisons with other towns might well be fallacious. Mr. Wise said that the entire cost, including meters, was £82,000. At present the undertaking was not paying. Mr. Parr: That is so; but as a matter of fact you have a rate in aid—how much does this amount to? Mr. Wise: For the year 1894 the rate in aid was £7,000, which included the public lamps, from which we get no revenue at all. We pay £300 rent for the main building, which is the same that the previous occupier paid. Mr. Parr contended that it was a fallacy that the public lamps were to be charged for at the same rate as private lamps. Looking at the whole cost of the undertaking at £82,000, he was going to submit that the amount of rating arrived at was a very moderate one indeed. What they had to find out was what would the undertaking let at from year to year. It was worth a great deal more than Mr. Wise had stated it would be in private hands, because there was to be added the £7,000 rate in aid. He asked the committee to discard the whole of the figures as far as the 90 lamps were concerned. Mr. Wise, replying to questions, distinctly assured the committee that up to the present no profit had been made either on the public or private supply. Mr. Parr said the position was simplicity itself; to the £3,760 they should add the £7,000. The first named was the estimated lamp revenue, and the £7,000 was the rate in aid. If this were done it would be seen that the rating was too moderate—that, in fact, it ought to be increased. Mr. Wise contended at length that the Erith case and the Merthyr Tydfil case established to the full the line he had taken. Mr. Parr still urged that there was no justification for the allowance of 20 per cent. in respect of the public lamps. The Chairman (Mr. R. C. Stephens) said the committee quite recognised that it was an appeal between two public bodies, and it would be their desire to establish a fair, impartial rate. The room was then cleared, and on the reassembling, the Chairman said they had gone into the figures very carefully, and had paid full attention to what had been urged. The committee would leave it to the parties to arrange the gross value, but they had fixed the ratable value at £1,500. The proceedings then terminated.

Light Railways.—The Public Health and Housing Commitee of the London County Council on Tuesday reported as follows: It will be remembered that the Council having been invited to send representatives to a conference convened by the Board of Trade on the subject of light railways, appointed Mr. Fleming Williams, Mr. Bruce, and Mr. Beachcroft to attend the conference. The conference having resulted in a Bill now before Parliament, a report on the subject is called for. The conference referred to at its first meeting in December last appointed a representative committee to consider "(1) how far the usual requirements of the Board of Trade as to constructing and working new railways may fairly be relaxed, especially in the case of lines built through sparsely-populated and agricultural districts, and (2) whether additional legal facilities for obtaining powers to construct tramroads and light railways are necessary or desirable" The President of the Board of Trade, in his opening address to the conference, treated the subject under two heads—namely, as affecting agricultural districts and in its relation to congested population. He further raised the question whether local authorities should have the power given to them of making or aiding in the making of cheap railroads. The committee, under the guidance of their chairman, Sir B. Samuelson, practically limited the enquiry to the case of light railways in agricultural districts, confining their consideration in this connection rather to the most likely method of cheapening parliamentary procedure and construction of lines than to the financial problem involved. As a result, a report was in February last presented to a further meeting of the conference and agreed to. This report expressed an opinion favourable to the authorisation and control of light railways being conferred on the local authorities, reserving an ultimate appellate jurisdiction to the Board of Trade, the belief being expressed that if this were done the initial cost of construction and expenses of working would be so reduced as to enable many light railways and tramways to be undertaken. The report concluded with an intimation that the committee refrained from giving an opinion as to the desirableness of local authorities being empowered to contribute towards or take part in undertakings of this character, doubting whether this was within the terms of the reference. Several memoranda were appended to the report by members, mostly dealing with the financial part of the question omitted from the report The Bill brought in by Mr. Bryce and Mr. Secretary Asquith, and now awaiting second reading, purports to give effect to the above report. The preamble of the Bill states its purport—viz, to provide by light railways further facilities for communication, especially in agricultural districts, and for that purpose to modify existing requirements. Briefly, the scheme of the Bill is to enable county councils to authorise the construction of light railways within their counties by means of an order made after public enquiry held by the county council. The order is to be submitted to the Board of Trade, which is to be charged with the duty of deciding whether the matter should go to Parliament, and as to the requirements for public safety and compulsory acquisition—subject, however, to agreement between the county council, the promoters, and the Board of Trade—an order is to have full effect. The provisions of the Lands Clauses Act are not to apply unless so provided by the order, and in any case all purchase and compensation money is to be settled by a single arbitrator appointed by the Board of Trade. The Bill also provides for the appointment, when required by reason of a light railway passing through several counties, of a joint committee, but it does not define the term "light railway," and it would seem (especially from the preamble referred to) that tramways are not contemplated in the term. The Bill does not, of course, exclude the Council from its operation, but it is evidently not framed with a view to embrace in its purview London and its suburbs. The Bill is silent on the financial part of the question, and is in short little, if anything, more than an attempt to revive in a modified form the Railways Construction Facilities Act of 1864, which enabled the Board of Trade to authorise a railway by means of a certificate, an Act which is said to have remained a dead letter owing to the fact that the consent of all persons beneficially interested is made a condition precedent to any certificate. The present Bill proposes to get over this part of the difficulty by constituting the Board of Trade the judge as to whether the views of dissenting parties are to prevail or not, thus shifting the responsibility from Parliament to a department of the State. It is possible that the Bill may in some cases be helpful and may encourage light railway enterprise in districts where landowners and others favour them, but for London and large urban districts it holds out no hope of assistance, and considering the twofold object of the conference, as indicated in Mr. Bryce's address referred to, it is disappointing to find that the Bill which is its product deals with but one of these objects, and that one in but a partial and hesitating manner. If the question of light railways is to be grappled with in connection with the needs of urban population it can only, we think, be by treating the term as synonymous with tramways and tramroads. We have, pursuant to a resolution of the Council of October 3, 1893, been engaged, through the statistical department, in collecting statistics relating to the whole question of locomotion as it

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affects London, and are about presenting to the Council a plan and return indicating all the existing railway, tramway, and omnibus routes. This plan will serve to show how far the tramway service of London is from a stage of fair development, extension into outer London, and consequent connection with the agricultural and producing districts. It appears to us that a measure such as the Light Railways Bill ought not to be allowed to become law without some strong representations being made of the views of the Council as to the urgent necessity for full enquiry into those branches of the problem left undisposed of, both by the recent conference and by the present Bill The following quotation from Mr. Bryce's address puts very clearly the question as it touches London. "There is," he said, "the question whether the local authority should have the power to make cheap railroads or aid in the making of cheap railroads, and, if it shall have power, whether that power should be given it in the form of enabling it to own and work the line, or only to make the line, and then to lease the line or to guarantee a minimum dividend upon the line; and whether there shall be any power reserved for the ultimate acquisition upon certain terms of the railroad by the local authority." These questions Mr. Bryce described as "very difficult ones," but they have been solved or are in course of solution in other countries, and unless they are faced here not only must the natural expansion of our cities be retarded, but no efforts will be found effectual to control overcrowding. We recommend that a communication be made to her Majesty's Government, expressing the hope that if the Light Railways Bill is proceeded with and referred to a select committee there may be added to that committee's reference a special instruction to make full enquiry into the questions above referred to, and that the Home Secretary and Mr. Bryce be asked to receive a deputation on the subject.

PROVISIONAL PATENTS, 1895.

JUNE 17.

11708. **Improvements in electrically and directly controlled switches for electricity.** Robert Pippette, 51, Upper Tulse-hill, London.

11728. **Improvements connected with galvanic batteries and switches therefor.** William Shaw, 70, Wellington street, Glasgow. (Complete specification.)

11748. **Improvements in the application of telephones to electric bell systems.** Frederick Hodgson and George Alfred Edwards, 8, Agincourt-road, Hampstead, London.

11752. **Electro-deposition of gold and silver.** Emile Andreoli, 18, Somerleyton-road, London. (Complete specification.)

11758. **Instantaneous automatic electric lighter for all kinds of gas burners.** Cesare Della Torrie and Francesco Mancini, 52, Chancery-lane, London.

11770. **Improvements in or relating to telegraphic transmitters and recording apparatus therefor.** Alfred Julius Boult, 323, High Holborn, London. (Charles Spiro, United States.)

JUNE 18.

11801. **Improvements in and relating to reflectors for electric incandescent lamps.** Charles Darrah, 70, Market-street, Manchester.

11817. **Improvements in apparatus for measuring or indicating the frequency of alternating or pulsating electric currents or potential differences or other periodic disturbances.** Albert Campbell, 34, St. George's square, Regent's Park, London.

11832. **Improvements in or relating to secondary batteries.** Alfred Julius Boult, 323, High Holborn, London. (Nathan Huntly Edgerton, United States.)

11842. **Improvements in rheostats and other circuit controllers.** Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (Charles Willms, United States.) (Complete specification.)

11864. **An improved plate for electric accumulators or storage batteries.** Paul Ribbe, 6, Lord-street, Liverpool. (Complete specification.)

JUNE 19.

11892. **A hand-feed lamp or regulator for the electric arc light for projection purposes.** Cecil Milton Hepworth, 45, St. Augustine's-road, Camden-square, London.

11944. **Improvements in the electrolytic deposition of metals and in means applicable therefor.** Charles Raleigh, 191, Fleet-street, London.

11951. **Improved system of telephonic exchange** Salomon Berditschewsky, called Apostoloff, 53, Chancery-lane, London.

JUNE 20.

11973. **Improvements in lights and reflectors for photography by electric and other lamps.** Charles Brooke Crawshaw and Rankin Kennedy, Hubert-street, Leeds-road, Bradford.

11976. **Improvements in electric safety lamps for use in mines and other places.** Henry William Headland, 77, Chancery-lane, London.

12035. **Mechanism for cutting off gas or electric current at any desired time.** Thomas Joseph Phipps, 24, Southampton-buildings, Chancery-lane, London.

11982. **Improvements in electromagnetic devices for automatically breaking the connections with the source of supply of electric light and power cables.** Sydney Ferris Walker, Cardiff Electrical Works, Severn-road, Cardiff.

12030. **Improvements in electric arc lamps.** William James Davy, 40, Chancery-lane, London.

12042. **Improvements in globes for arc lights or other lights of great intensity.** William Jandus, 18, Southampton-buildings, Chancery-lane, London.

JUNE 22.

12157. **Improvements in electric lighting, specially applicable for lighting vehicles.** Francis Louis Berners and Frederick Griffin, 40, Chancery-lane, London.

12161. **Improvements in apparatus for automatically indicating the fracture of electric conductors.** Adrien J. Moulart, 1, Queen Victoria street, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1892.

19714. **Dynamo-electric machines.** Chitty. (Second edition.)

1893.

21628. **Telegraphy.** Delany. (Second edition.)

1894.

10463 **Electric batteries.** Moffat.

13700. **Telephone switchboard mechanism.** Kingsbury. (Western Electric Company.)

13499. **Electrolytical decomposition of alkali salts.** Sinding-Larsen. (Second edition.)

1895.

3178. **Testing boxes, etc., for electric mains.** Macpherson.

4497. **Electromagnetic apparatus for operating indicators, etc.** Von Morstein.

5700. **Electric arc lamps.** MacIntire.

6249. **Aerial electric railway systems.** Boult. (Kilmore.)

7142 **Alternating currents.** Manchester Edison-Swan Company and others.

7795. **Electric accumulators.** De Dormael.

8590. **Magnetic ore separators.** Carter.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Brush Company, Ordinary	3	2¼-2⅜
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2⅜
—— 4½ Debenture Stock	100	112-115
Charing Cross and Strand	5	5¼-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	130-135 xd
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A, 1-200 of £50	100	—
Electric Construction, Limited	2	⅜-½
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1¾-2½
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1½
Elmore's Wire Company	2	1½-1⅝
Fowler-Waring Cables	5	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	10½-11½
—— 7 per cent. Preference	10	14-15
—— 4½ per cent. Debentures	100	103-106
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	7¼-7½
India Rubber and Gutta Percha Works	10	17-19
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7¼-7⅜
—— Pref.	—	—
Liverpool Overhead Railway	10	9 15/16-10 1/
—— Pref.	10	14¾-15½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	⅛-¼
Metropolitan Electric Supply	10	10½-10¾
—— 4½ per cent. First Mortgage Debenture Stock	100	115-117 x
National Telephone, Ordinary	5	5½-5⅝
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Non. Cum. Third Pref.	5	5¾-6⅛
—— 3½ per cent. Deb. Stock	100	104-106
Notting Hill Company	10	8-8½
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5¾-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8¾
—— 7 per cent. Pref.	5	9-9¼
Swan United Ordinary	3	1⅞-2⅛
—— 4½ per cent. Debentures	100	105-108
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	106-109
Westminster Electric Supply, Ordinary	5	7¾-8⅛
Yorkshire House-to-House	—	6¼-6⅝

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